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Alternative and Renewable Energy Policy in Europe

Master's thesis

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ABSTRACT

Driven by the fact that the global oil market has become extremely volatile and the EU dependence on oil continues to grow, this paper argues that with more emphasis on renewable energy and by using domestically produced alternative energy sources instead of importing foreign oil the EU Member States would drastically improve their energy security and energy independence. The study investigates both past and present trends in the EU energy sources supply and consumption patterns. Additionally, the paper considers possibilities of the renewable and alternative energy both at the current stage and future development of this sector in the EU. The research findings confirm the initial hypothesis as to whether the share of alternative and renewable energy will be sufficiently large to contribute to solving a problem of the EU energy security and independency. The role of the renewables in national energy security strategies of three EU Member States is studied and government supporting policies that enhance renewable sources development are analyzed.

Keywords

Renewable energy policy, European Union, energy market, solar, wind, nuclear power, alternative energy sources.

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DECLARATION OF AUTHORSHIP

1. The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

2. The author hereby declares that all the sources and literature used have been properly cited.

3. The author hereby declares that the thesis has not been used to obtain a different or the same degree.

Prague 15.05.2015 Faig Orujov

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Master Thesis Proposal

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Proposed Topic:

Alternative and Renewable energy policy in Europe

Motivation:

Threat of lack of necessary resources such as oil and gas today, is becoming ever more real for many countries. In the energy strategy of the state, both in the short and in the long run as one of the main components indicated the need to ensure energy security and an effective energy security policy, regulation and coordination of performing energy sector development in its entirety from the evaluation, exploration to production resources. Changes in the global energy market and even the probability of an energy crisis affect the economy of the European Union, which at the largest production capacity in the world has the lowest own production of traditional energy sources. Thus, in order to maintain economic growth and prosperity of the European region, it needs to ensure uninterrupted access to energy.
In this thesis I would like to identify the role of alternative and renewable energy in the general strategy of energy security of EU.

Hypotheses:

Hypothesis 1. The share of alternative energy will be sufficiently large to contribute to solving a problem of energy security and dependency.
Hypothesis 2. Renewable energy sources will reduce dependency of European Union on Russia fossil fuels.

Methodology:

This paper studies alternative and renewable energy policy in European counties. For empirical analyzing I use such methodological approaches as comparative analysis and analysis of secondary statistical data, analysis of legal regulations.

Outline:

1. Introduction
2. The energy security problem of European countries

2.1 The EU provision of energy sources
2.2 Possibilities of alternative and renewable energy at the modern stage

3. Potential of EU energy policy to tackle energy security problems

3.1 Evolution of energy policy

3.2 New trends in EU energy policy
3.3 The role of renewable energy sources in the energy strategy of EU Member States
3.3.1. Germany
3.3.2. France
3.3.3. Spain
4 Conclusion

Core Bibliography:

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CONTENTS

List of Abbreviations 10
1.INTRODUCTION 12
2. THE ENERGY SECURITY PROBLEM OF EUROPEAN COUNTRIES 15
2.1 THE EU PROVISION OF ENERGY SOURCES 15
2.2. POSSIBILITIES OF ALTERNATIVE AND RENEWABLE ENERGY AT THE MODERN STAGE 26
3. POTENTIAL OF EU ENERGY POLICY TO TACKLE ENERGY SECURITY PROBLEMS .. 39
3.1 EVOLUTION OF ENERGY POLICY 39
3.2 NEW TRENDS IN EU ENERGY POLICY 48
3.3 THE ROLE OF RENEWABLE ENERGY SOURCES IN THE ENERGY STRATEGY OF EU MEMBER STATES 60
3.3.1. GERMANY 61
3.3.2. FRANCE 66
3.3.3. SPAIN 72
CONCLUSION 78
BIBLIOGRAPHY 80
LIST OF APPENDICES 88
APPENDICES 89

List of Abbreviations

AEBIOM – European Biomass Association

CCS – Carbon Capture and Storage

CNG - Compressed Natural Gas

dena - German Energy Agency

EAP – Environment Action Programme

EC – European Commission

ECCP – European Climate Change Programme

ECSC – European Coal and Steel Community

EEA - European Environment Agency

EIA – U.S. Energy Information Administration

EPIA - European Photovoltaic Industry Association

EREC – European Renewable Energy Council

ETS – EU emissions trading scheme

EU – European Union

EU-OEA – European Ocean Energy Association

EURELECTRIC – Union of the Electricity Industry

EUROATOM – European Atomic Energy Community

EWEA - European Wind Energy Association

FIT - feed-in tariff

FQD – Fuel Quality Directive

GHG - greenhouse gas

GTL - Gas-To-Liquid

IEA – International Energy Agency

IEEP – The Institute for European Environmental Policy

IIEA – Institute of International and European Affairs

IMO – International Maritime Organisation

IPCC – Intergovernmental Panel on Climate Change

LNG - Liquefied Natural Gas

LPG - Liquefied Petroleum Gas

NREAP – National Renewable Energy Action Plan

PV – photovoltaics

R&D – research and development

RD&D – Research, Development and Demonstration

RED – Renewable Energy Directive

RES – renewable energy sources

SECA – Sulphur Emission Control Area

SET – Strategic Energy Technology

SI Ocean - Strategic Initiative for Ocean Energy

TFEU – Treaty on the Functioning of the European Union

1. INTRODUCTION

Earlier ghostly and distant threat of lack of necessary resources such as oil and gas nowadays is becoming ever more real for many countries. In the energy strategy of the state both in the short and in the long run as one of the main components indicated is the need to ensure energy security and effective energy security policy, regulation and coordination of performing energy sector development in its entirety from the evaluation, exploration to production resources. Changes in the global energy market and even the probability of an energy crisis affect the economy of the European Union, which at the largest production capacity in the world has the lowest own production of traditional energy sources. Thus, in order to maintain its economic growth and prosperity, the European region needs to ensure uninterrupted access to energy, as well as the reliability and security of the energy supply.

Growing demand for energy along with increasing prices of energy make the topic of energy security extremely relevant nowadays, raising concerns regarding a variety of issues, most of which are associated with the reliability and affordability of energy supply. Since Europe is highly dependent on a limited number of energy sources suppliers, it raises high risks for the energy supply security of these countries. This problem may be even worsened by taking into considerations such factors as political tense and military conflicts in the world that have direct influence on energy prices and supply. Risks to national energy security can also lead to negative effects on energy security at local levels. Recently, the perception that dependence on Russian gas leads to unacceptable geopolitical risks in relation to countries' national security becomes more relevant, which makes the EU undertake measures in order to secure its energy sector.

In addition to this, nowadays energy system is highly carbon-intensive and depends on a finite supply of fossil fuels that are getting harder and more expensive to extract, which raises concerns about national energy security in many countries, particularly in the EU. Furthermore, the modern state of the energy sector is complicated and many countries are exposed to large swings in oil import prices and also costs in terms of billions in public subsidies. Therefore, renewable and alternative energy sources such as wind power, solar energy, hydropower, biofuels and natural gas in compressed or liquefied form can play a major role in tackling the twin challenge of energy security and global warming because they do not deplete and produce less greenhouse-gas emissions than fossil fuels. Since the EU in its policies addresses climate issues, in many regards its energy and environmental objectives go hand in hand.

Another side of the problem under study is the fact that most renewable and alternative energy industries are still young, so that these industries face low demand from consumers, and additionally, a severe competition from other well-established energy industries such as the coal and nuclear industries. Moreover, the production of clean energy also possesses high launching and operating costs. Companies in many undeveloped renewable energy industries find it very difficult to recover these high costs over the lifecycle of a facility, even though such lifecycles can last decades.

With a view to this issue, all EU countries have adopted national renewable energy action plans showing what actions they intend to take to meet their renewables targets. These plans include sectorial targets for electricity, heating and cooling, and transport, planned policy measures, mixes of renewables technologies they expect to employ and cooperation mechanisms. As strong growth in renewable energy capacity in Europe shows, wise government policies and encouraging incentives can have a real impact on the fortunes of these technologies.

With regard to the abovementioned problems and policies described, this paper aims to analyze current EU energy situation and verify two main hypotheses. First hypothesis is whether the share of alternative and renewable energy will be sufficiently large to contribute to solving a problem of the EU energy security and independency. Second hypothesis is whether renewable energy sources will reduce dependency of the EU and its Member States on Russia and other fossil fuel exporters.

The thesis will be based mostly on the empirical analysis, using both quantitative and qualitative approaches. The first hypothesis will be tested with the help of analysis of quantitative data provided by the most recent reports of various energy-related organizations along with the comprehensive study of the outlooks and projections for separate types of energy for the distant future. Moreover, the study of legal documents related to the EU energy field will be conducted in order to identify the framework of the renewable and alternative energy development both now and in the long term. The second hypothesis will be tested with the help of data analysis and such methodological tools as statistical and comparative analysis, analysis of legal regulations and case studies (Germany, France, Spain). The author aims at conducting a comprehensive analysis of the current situation on the EU energy market with respect to energy security and sustainability aspects, as well as investigates the outlooks and targets for energy sector development within the EU. Based on the obtained findings, the author will argue the validity of the initial hypotheses. The literature used for the research contains the most recent reports by the organizations and authorities related to the energy sector of the EU, as well as includes books, articles and publications of the researchers and professionals in the field, and finally it also contains primary sources of the EU legislation.

Based on the outlined motivation and hypotheses, this research approaches the study of renewable and alternative energy sources in the EU in the following way. First the EU provision of energy sources will be investigated as well as the possibilities of alternative energy sources will be outlined thereby identifying energy security problems of the European Union member countries. Furthermore, a retrospective analysis of the EU energy policy as well as its new trends and the role of renewable and alternative energy sources in the energy strategy of three EU Member States will be investigated. Countries' strategies differ when it comes to supporting fossil fuels, so the renewable sector must compete with a unique price structure for these fuels in each country, therefore energy strategies of France, Germany and Spain will be analyzed separately.

The task of the paper is not only to describe past and present situation on the EU energy market, but also to assess governmental policies of the EU in general and in some countries separately, highlight crucial issues with respect to energy security and efficiency, evaluate support provided to the renewable sector within the EU and finally outline some perspectives of the energy sector development taking main renewable energy subsectors into account. In order to spur sustained investment in renewable energy, a clear, long-term policy perspective is necessary. Therefore, the analysis of future trends is of great interest, since the EU sets goals for a distant future, i.e. up till 2020, 2030 and 2050, so the analysis of current and future trends is highly relevant.

2. THE ENERGY SECURITY PROBLEM OF EUROPEAN COUNTRIES

2.1 THE EU PROVISION OF ENERGY SOURCES

According to the general principles of energy policy published by the European Parliament, challenges facing the EU in the field of energy include the following important issues: increasing import dependency, limited diversification, high and volatile energy prices, growing global energy demand, security risks affecting producing and transit countries, the growing threats of climate change, slow progress in energy efficiency, challenges posed by the increasing share of renewables, and the need for increased transparency, further integration and interconnection on energy markets (EU Parliament, 2014).

The most important issue with respect to the EU energy security is the problem of import dependency. Following the most recent evidence provided by the European Commission, the EU imports more than half of all the energy it consumes. Its import dependency is particularly high for crude oil (more than 90%) and natural gas (66%). The total import bill is more than €1 billion per day. (EC, 2014a)

In addition to this, many EU member countries are also heavily reliant on a single supplier, including some that rely entirely on Russia for their natural gas. This dependence leaves them vulnerable to supply disruptions, which can be caused by political or commercial disputes, or infrastructure failure. For instance, a 2009 gas dispute between Russia and transit-country Ukraine, left many EU countries with severe shortages (EC, 2014b). Current political situation in the Eastern Ukraine and Russia involvement into it strengthen the belief that the EU and its member countries should find alternative sources of energy supply in order to ensure the stability of the EU internal energy market.

A variety of measures aiming to achieve an integrated energy market, security of energy supply and sustainability of the energy sector are at the core of the European Union energy policy (EU Parliament, 2014). Moreover, in response to the aforementioned concerns, the European Commission released its Energy Security Strategy in May 2014. The Strategy aims to ensure a stable and abundant supply of energy for European citizens and the economy. (EC, 2014b)

Before considering the policy implication issues, it is worth analyzing the EU provision of energy resources in order to define main strengths and weaknesses of the market with further analysis of its impact on the security issues. Thus, according to Eurostat statistics, the production of primary energy in the EU-28 totaled 794.3 million toe in 2012. This continued the generally downward trend observed in recent years, with 2010 the main exception as production rebounded after a relatively strong fall in 2009 that coincided with the financial and economic crisis. When viewed over a longer period, the production of primary energy in the EU-28 was 15.7 % lower in 2012 than it had been a decade earlier. The general downward trend of EU-28 production may, at least in part, be attributed to supplies of raw materials becoming exhausted and/or producers considering the exploitation of limited resources uneconomical (Eurostat, 2014b).

The highest level of primary energy production among the EU member states was in France, with a 16.8 % share of the EU-28 total, followed by Germany (15.6 %) and the United Kingdom (14.6 %). Compared with a decade earlier the main change was the fall in the share of the United Kingdom, down from 27.1 %. The only other member states whose shares fell over this period were Denmark (-0.6 percentage points) and Lithuania (-0.4 percentage points). In absolute terms, the largest expansions in the production of primary energy during the 10 years to 2012 were registered in Italy and Sweden (both up 4.4 million toe), and the Netherlands (up 4.3 million toe) (Eurostat, 2014b).

Having considered some general statistical evidence, it is worthwhile to carry out a dynamic analysis of the development of production and consumption trends within the EU and conduct a comparative analysis of the results. I start with the investigation of primary production of energy sources inside the EU-28 and gross inland consumption within the EU-28 along the period 2004-2013. The trends, based on the Eurostat data, are plotted on the graph below.

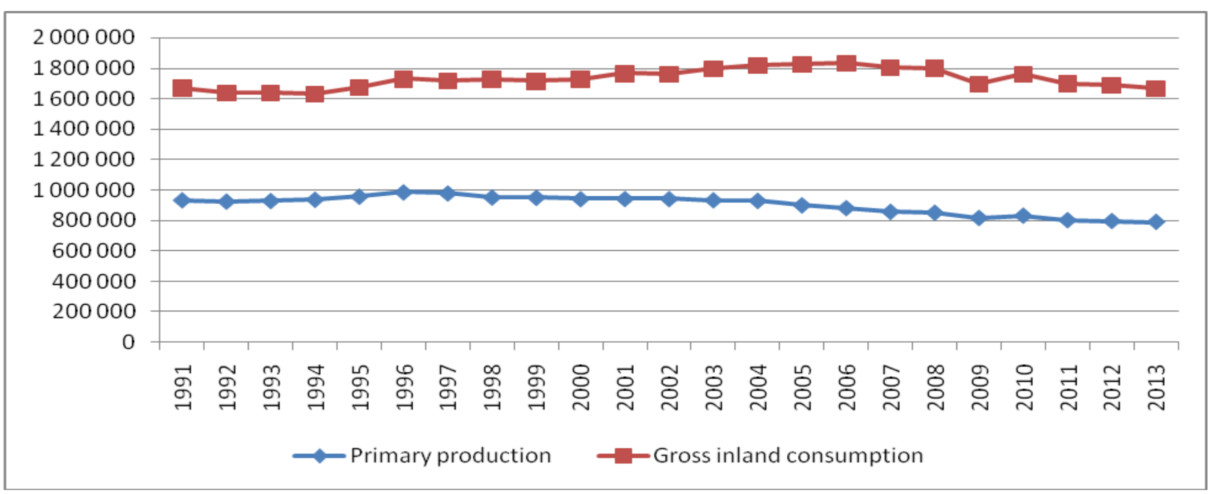

Fig.1. EU-28 inland total production and total consumption of energy sources, in thousand TOE

Source: author’s calculations based on Eurostat data

According to the graph, it is easy to see that the primary production of energy sources is lower than the consumption and the gap between the two has to be covered by imports. Moreover, what is also visible from the graph, the primary production of energy sources has somewhat declined in the EU during last four years and the inland consumption seems not to be increasing. Therefore, this finding explicitly shows the necessity of the EU's import of fuels in order to satisfy needs in energy. The aim of this paper is therefore to identify whether the share of renewable and alternative energy sources could be large enough in order to sufficiently cover the gap between demand and supply of energy sources in the EU.

However, the EU-28 is too heavily dependent on fossil fuels, which accounted in 2012 for 74.6% of the total gross inland energy consumption compared to renewables at only 11%. The data provided in the latest 2015 report published by the European Environment Agency (EEA) evidences that the share of fossil fuels (gas, solid fuels and oil) in the total gross inland energy consumption of the EU-28 declined from 83% in 1990 to 74.6% in 2012 at an annual rate of 0.3 % per year. Between 2005 and 2012, the share of fossil fuels in gross inland energy consumption decreased slightly faster at 0.6 % per year (EEA, 2015a). Based on this evidence we can see that there is some potential for the renewable and alternative energy sources to overtake a gap between supply and demand and thereby substitute import of fossil fuels from abroad. At least the data provided above evidences that since the EU started an active renewable-enhancing policy, the share of fossil fuels in total energy consumption has decreased, which is a good sign for future development.

This was a description of the broad picture and general trends in the EU provision of energy resources. Next, it is also important to distinguish where this import-dependence comes from, namely whether the EU countries import from each other and/or their sources of supply are very diversified, which would not constitute a problem here or create threats to internal market energy security, or whether they import from non-EU countries from a rather limited number of suppliers, in which case the energy security issue is likely to arise. The investigation of this issue will help in the process of validation of the initial hypotheses of this study.

As reported by Eurostat, the downturn in the primary production of hard coal, lignite, crude oil, natural gas and more recently nuclear energy led to a situation where the EU was increasingly reliant on primary energy imports in order to satisfy demand, although this situation stabilized in the aftermath of the financial and economic crisis. The EU-28's imports of primary energy exceeded exports by some 922.8 million toe in 2012. The largest net importers of primary energy were generally the most populous EU Member States, with the exception of the United Kingdom and Poland. Since 2004, the only net exporter of primary energy among the member states has been Denmark (Eurostat, 2014b).

Following the data of the report by EEA, we can see that the EU's dependence on imports of fossil fuels from non-EU countries remained relatively stable between 2005 and 2012. In 2012, EU-28 net import of fossil fuels was 53.4% of its total gross inland energy consumption with 58.2% for oil, 28.3% for gas and 13.6% for solid fuels (data provided as a share of fuel-specific gross inland consumption of a particular source). In 2012 only 71.4% of the total gross inland energy consumption in the EU-28 reached the end users (EEA, 2015a).

The graph below based on data provided by Eurostat shows that the imports of all types of fuels constitutes a huge amount of fuels consumption. All products is the sum of net import of solid fuels, gas and total petroleum products as a percentage of total gross inland consumption of all products.

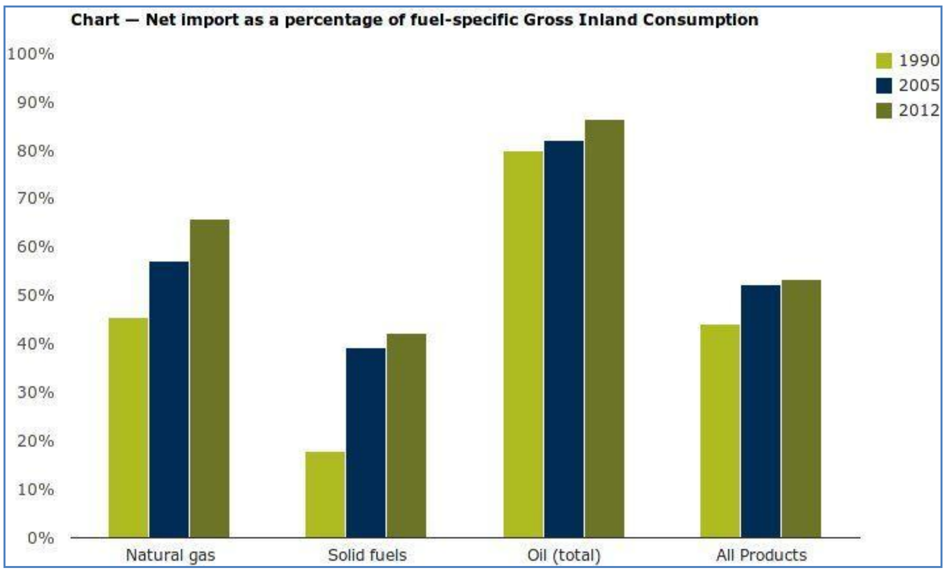

Fig.2. Net import as a share of fuel-specific gross inland consumption, in percentages

Source: Eurostat

In addition to fossil fuels, the EU imports uranium for its nuclear power industry which accounted in 2012 for about 38% of the world's civil nuclear power generation. The EU industry has the capacity for uranium enrichment and fuel fabrication, but is dependent on imported uranium. Nevertheless, the situation is somewhat better (with respect to the diversity of supply) than for most fossil fuels, due to the wide distribution of uranium around the globe, in geopolitically stable areas. In 2012, 27% of uranium delivered to utilities in EU-28 originated from Russia, 17% from Canada, 13% from Niger, 12% from Australia and another 12% from Kazakhstan (EEA, 2015a).

Taking a closer look at the nuclear energy sector in the EU, it can be mentioned that according to the World Nuclear Association there are 131 nuclear power reactors operating in 14 of the 28 EU member states account for over one-quarter of the electricity generated in the whole of the EU. Half of the EU's nuclear electricity is produced in only one country – France. The 53 units operating in three non-EU countries (Russia, Ukraine and Switzerland) account for about 17% of the electricity in the rest of Europe. Norway and Switzerland are effectively part of the EU synchronous grid. In 2013 about 43% of EU uranium came from Kazakhstan and Canada, followed by Russia, Niger and Australia (World Nuclear Association, 2015).

Despite the fact that establishment and operation of power generating capacity is undertaken on a national basis, the electricity is mostly traded across national boundaries in the EU, which leads to the fact that a particular country's energy policies have significant implications for its neighbors.

As reported by the World Nuclear Association, in spite of the fact that nuclear is a proven source of low-carbon, dispatchable electricity giving a high degree of energy security and provides 53% of the EU's carbon-free electricity, the sector today faces major challenges within the EU (World Nuclear Association, 2015). This happens due to the fact that some member states are strongly anti-nuclear, and electricity markets are often structured in response to support renewables nowadays.

The same organization argues that in the period to 2030, nuclear capacity that will be lost due to the closure of a number of reactors – either because they have reached the end of their operating lifetimes or due to political interference – is expected to outweigh that gained from new reactors. A slight decrease from the current EU nuclear capacity of 122 GWe is therefore expected in the near term as reported by the Nuclear Association. Total EU generating capacity in 2011 was 903 GWe, almost one-third of this in Germany and France (World Nuclear Association, 2015).

It is also important to mention that nuclear plant construction is currently underway in only three EU member states – Finland, France and Slovakia. These construction projects have all experienced cost overruns and delays. Further new units likely to come online before 2030 are planned or plausibly proposed in Bulgaria, Czech Republic, Finland, France, Hungary, Lithuania, Poland and the United Kingdom. According to the report by the World Nuclear Association, the long-term future of nuclear power in the EU is likely to depend on the outcome of these projects, which are relatively few in number – in total less than planned in Russia (World Nuclear Association, 2015).

It is worth taking a brief look at the trend of import dependence on Russia energy sources supply development, since identification of this trend could help to understand how this issue evolved over time. Moreover, according to the second initial hypothesis of my study, it is important to explore the patterns of the EU dependence on Russia's import in order to be able to argue that the renewables will be able to constitute the amounts of energy needs currently covered by Russia.

Figure 3 below depicts the development of the import of all energy sources by the EU-28 from Russia. It is obvious that the trend has been steadily increasing with a somewhat rapid a slightly significant decrease in absolute values between 2008 and 2009. This is likely to have been caused by the worldwide economic crisis. It is also noticeable that after decreasing in 2008 this trend has been more or less stable and did not return back to its pre-crisis level. It is important to mention that a 2009 gas dispute between Russia and transit-country Ukraine, left many EU countries with severe shortages, which may have also added to this decrease in imports. The aforementioned explanations may indicate that the EU countries decided to reevaluate their energy supply security issues and since 2008 maintained the imports from Russia on a steady level.

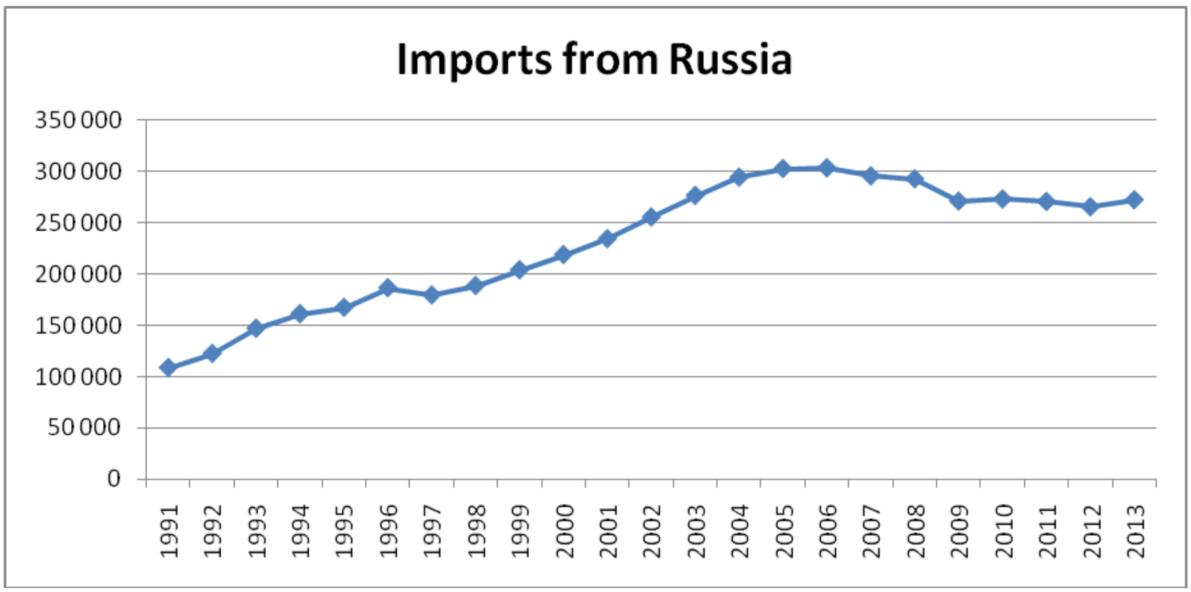

Fig.3. Imports from Russia to the EU-28, all products, in thousand TOE

Source: author's calculations based on Eurostat data

Russia, and specifically Gazprom, is the largest single supplier of gas to European countries. According to the study conducted by Oxford Institute for Energy Studies, in 2013 Gazprom exported a record volume of gas to Europe, significantly exceeding deliveries in the 2008– 2012 period and, due to a fall in European demand and deliveries from other indigenous and external suppliers, representing 34% and 30% respectively of European imports and demand.

As reported by the same research, the vast majority of Russian gas exports to Europe are sold on long-term contracts varying from 10 to 35 years in length. These contracts, which are legally binding and subject to international arbitration, contain take-or-pay clauses which require buyers to pay for a minimum annual quantity of gas, irrespective of whether they take that quantity. In the post-2008 period, the take-or-pay level in many of these contracts was reduced from 85 to 70%.

It should be highlighted that these contracts are designed in such a way that there are significant limitations on the options to reduce the volumes in these contracts or regarding terminations of the contracts before expiry. Up till now, despite difficult renegotiations and a large number of arbitration proceedings, no such actions have been reported (Dickel et al.,2014).

Therefore, as can be seen from this evidence, the dependence on Russian fossil fuels is not only in terms of energy supply but also in terms of commitment and inflexibility of the contracts signed. All these factors trigger threats for the EU energy security and create firm grounds for promotion of the renewable and alternative energy sources. The aforementioned data and contractual commitments also evidence against the possibility of renewable and alternative energy sources to substitute imports from Russia to a great extent and at least until 2020.

Nevertheless, not only economic factors matter with respect to this issue. The Russian reaction to political events in Ukraine in 2014, and specifically its annexation of Crimea, military involvement in eastern Ukraine, and the Malaysian airlines MH17 disaster, has generated a great deal of commentary about European dependence on Russian energy in general and natural gas in particular. Additionally to these events, some price dispute evolved which led to termination of Russian supplies to Ukraine in June 2014, and the possibility of interruptions of gas supplies to Europe (Dickel et al., 2014). This situation and speculations performed by the Russian authorities reminded Europe about 2009 problems and signified the unreliability of Russia as energy supplier for the EU. Thus, all this led to renewed calls for diversification of European gas supplies and reduction of Russian imports.

In order to sum up the issue of the EU import dependence on Russia, the graph below is provided. The figure shows a simple dependence chart with European imports of Russian gas (adjusted to European units) plotted against European demand for the period 1990–2013. As can be seen from the time series data, it is clear that the share of imports was relatively steady (in the range of 20–25%) until 2013, when European demand fell and Russian exports increased, at which point it reached 28% of the total.

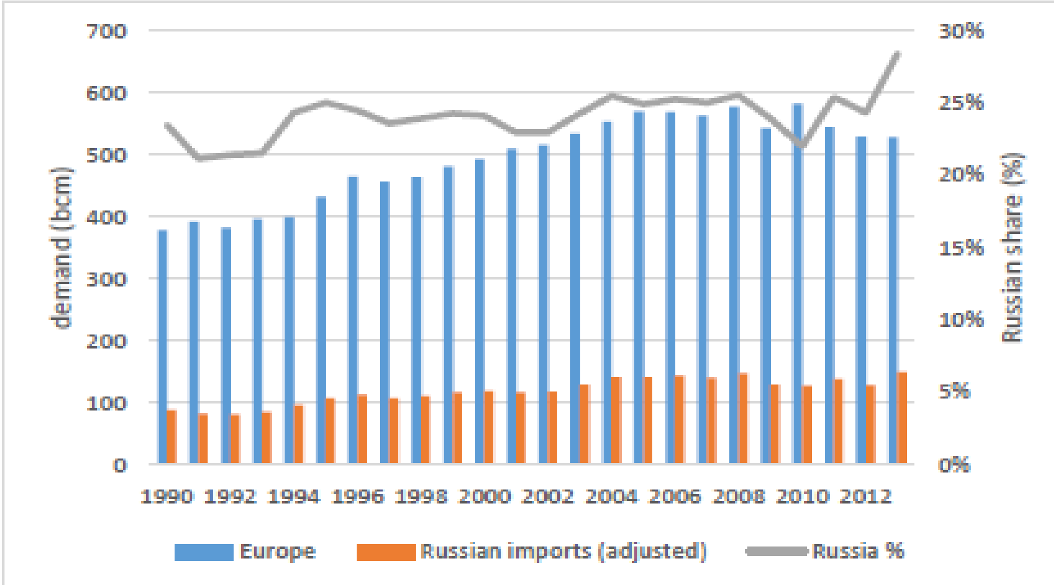

Fig.4. Share of Russian gas in European demand 1990–2013 (bcm and %)

Source: Dickel et al., 2014

According to the Eurostat data, the origin of EU-28 energy imports has changed somewhat in recent years, as Russia has maintained its position as the main supplier of crude oil and natural gas and emerged as the leading supplier of solid fuels. In 2012, some 33.7 % of the EU-28's imports of crude oil were from Russia, slightly below the shares recorded for 2010 (34.7 %) and 2011 (34.8 %). Russia became the principal supplier of solid fuels in 2006. Russia's share of EU-28 solid fuels imports rose from 13.1 % in 2002 to 30.0 % by 2009, before falling somewhat to 25.9 % by 2012. Despite this contraction, Russia remained the primary source of solid fuels imports into the EU in 2012 (Eurostat, 2014b).

These data evidences that in order to satisfy the second initial hypothesis of this paper as to whether renewable energy sources will reduce dependency of the EU and its Member States on Russia and other fossil fuel exporters, the EU and its Member States should work more actively on switching to alternative and renewable energy and sharply increasing their share in the energy mix, thereby reducing volumes of fossil fuels supply from Russia.

In its May 2014 Communication on European Energy Security Strategy, the European Commission summarized dependence on Russian gas as follows: "Six Member States depend from Russia as single external supplier for their entire gas imports and three of them use natural gas for more than a quarter of their energy needs. In 2013 energy supplies from Russia accounted for 39% of EU natural gas imports or 27% of EU gas consumption" (EC, 2014b, p.2).

It is, however, important to emphasize that the net dependence on fuel imports varies significantly across the EU member states. This in its turn reflects differences in the availability of indigenous fossil resources and renewables. In addition to this, the level of crude oil import reflects the availability of refining capacity and direct production of final products. Therefore, for some countries there is limited or no refining capacity, as in case of Luxembourg, and hence only final products are imported (EEA, 2012).

Having considered the EU home production of energy sources as well as trends in imports of the resources especially from Russia, it is now appropriate to analyze another important issue under the problem of the EU provision of energy sources. This issue is the EU provision of the renewable energy sources. This aspect will be more comprehensively investigate in next sections, but a brief overview is needed here as well in order to complete the analysis of the issue under study in this section, i.e. the EU provision of energy sources.

Let’s now turn directly to the production side of renewables inside the EU. Thus, according to data from Eurostat, the primary production of renewable energy within the EU-28 in 2012 was 177.3 million toe — a 22.3 % share of total primary energy production from all sources. The quantity of renewable energy produced within the EU-28 increased overall by 81.3 % between 2002 and 2012, equivalent to an average increase of 6.1 % per year (Eurostat, 2014a). These data evidence that wise support policies by the governments helped the EU Member States to increase the production of their own energy, which is a good starting point for reducing their dependence on Russia and other foreign fossil fuels suppliers, thereby these data contributes to the validity of the second initial hypothesis stated in the beginning of this study.

There are, however, uneven trends among the EU Member states in developing the renewable energy sources. Thus, the largest producer of renewable energy within the EU-28 in 2012 was Germany, with an 18.6 % share of the total; France (11.7 %), Sweden (10.4 %) and Italy (10.1 %) were the only other EU Member States to record double-digit shares (Eurostat, 2014a). These data evidence in favor of our initial hypotheses, since this trend demonstrates that the above mentioned countries are the main driving forces within the EU in terms of renewable and alternative energy implementations, which means that their successful example is likely to positively influence rest of the EU Member states, thereby sufficiently increasing the share of alternative and renewables in the energy mix and reducing the import dependence on foreign countries in the long run.

There were considerable differences in the renewable energy mix across the Member States, which reflect to a large degree natural endowments and climatic conditions. For example, more than

62.5 % of the renewable energy produced in Cyprus was from solar energy, while more than a third of the renewable energy in the relatively mountainous countries of Austria, Slovenia and Croatia was from hydropower. More than 27.7 % of the renewable energy production in Italy was from geothermal energy sources due to active volcanic processes happening there. The share of wind power was particularly high in Ireland (46.3 %) and also accounted for more than 20% of renewable energy production in Portugal, the United Kingdom, Denmark and Spain. The output of renewable energy in Malta grew at an average rate of 22.7 % per year between 2002 and 2012, although the absolute level of output remained by far the lowest in the EU-28. Over this same period, annual increases averaging in excess of 10.0 % were recorded for Belgium, Germany, Ireland and the United Kingdom, with Luxembourg and Cyprus just below this level (Eurostat, 2014a).

Having overviewed the production aspect of the renewable energy in the EU, it is now important to consider the consumption side of the issue. Thus, according to the European commission and the data from Eurostat, renewable energy sources accounted for an 11.0 % share of the EU-28's gross inland energy consumption in 2012. Over one third of the energy consumed in Sweden (37.2 %) and Latvia (36.4 %) was derived from renewables in 2012, while the relative importance of renewables was also high in Austria (30.1 %), Finland (29.2 %) and Denmark (23.3 %) (Eurostat, 2014a).

It can be highlighted that after a period up to 2010 during which renewables were growing strongly, the combined effect of warm weather, slower progress by Member States in implementing the Renewable Energy Directive and Europe's faltering economic situation led to a decrease in the use of renewable energy in 2011. However, the share of renewable sources in gross final consumption of energy did increase, since the consumption of fossil fuel energy fell more than that of renewables. In 2012 the share of energy from renewable sources increased again and reached 14.3 % and increased further to 15.0 % in 2013 (Eurostat, 2015a).

It is noteworthy to point out that according to the EEA report on energy support measures in EEA countries and innovation in the renewable sector, in total 582 support measures have been identified that were in place in 2012 in the 32 EEA countries (vast majority of which are the EU Member States). Of the total 582 measures, 310 are associated with fossil fuels, and 236 with renewable energy (including biofuels), representing 40.5 % of the identified support measures. About 6% of the identified support measures were targeted at electricity and/or heat production and consumption, and therefore did not alter the competitive situation between renewables and fossil fuels (EEA, 2015b). Figure 5 below displays the distribution of energy support measures in the EEA countries as of 2012.

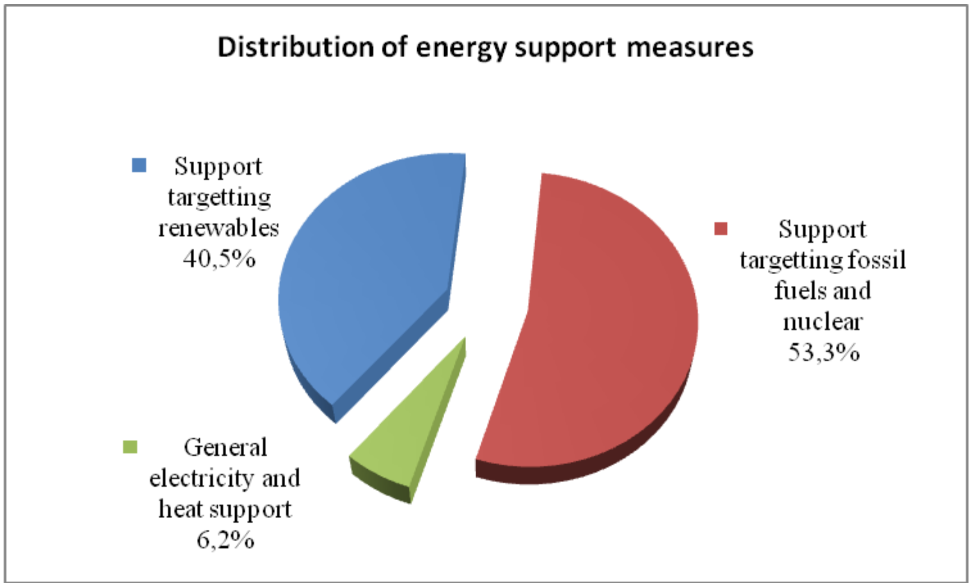

Fig.5. Distribution of energy support measures, 2012, EEA-32

Source: EEA, 2015b, p.15

As can be seen from Figure 5, in 2012, EEA countries had in place more measures to support fossil fuels and nuclear than to support renewable energy. This is particularly due to the desire to keep certain economic sectors competitive.

To sum up the findings of this section, we can conclude that the EU is somewhat poorly supplied with its own energy resources. Having estimated the dynamic trends of the EU total energy production and inland consumption, we have identified a large gap between them, which emphasizes the necessity of importing energy sources. The dependence of the EU supply of energy sources on Russian imports and the threats this issue brings to the EU energy security have been outlined. The dynamic trend of the import pattern demonstrates that after 2008 the European countries decreased their consumption of Russian energy sources presumably due to economic crisis and some political issues that involved Russia, so that nowadays the imports is more or less at the same level.

I continue further in investigation the internal EU market of renewable sources and conclude that almost all member countries are increasing both the production and the consumption of renewables aiming at reaching the EU 2020 objective.

2.2. POSSIBILITIES OF ALTERNATIVE AND RENEWABLE ENERGY AT THE MODERN STAGE

It is first important to highlight that renewable energy sources are not exactly the same as alternative energy sources. Alternative energy is a broader category encompassing all non-fossil-fuel-based energy sources and processes, of which renewable energies are only a part (Globalization101, 2015).

Motivation of investigating the issue of possibilities of alternative energy in the EU is driven to a great extent by the fact that Europe is heavily dependent on imported oil for its mobility and transport, which dampens its energy security but can be avoided with the help of alternative energy sources. Thus, according to the data provided by the European Commission as of 2013, in 2010, oil counted for 94% of energy consumed in transport, with 55% the largest consumer, 84% of it imported, with a bill of up to €1 billion a day in 2011, leading to a significant deficit in the EU trade balance of around 2.5% of GDP (EC, 2013a).

Moreover, the EU supply of oil, and thus the mobility of its citizens, depends to a large degree on politically unstable regions raising security of supply concerns. Price hikes driven by speculation on the impact of oil supply disruptions have cost the European economy an additional € 50 billion per year over the last four years. The effect of the oil dependency on the European economy is too large to neglect, which creates a necessity of recruiting alternative energy sources into the supply process. A strategy for the transport sector to gradually replace oil with alternative fuels and build up the necessary infrastructure could bring savings on the oil import bill as well as ensure the energy supply stability and lower dependence on external providers.

The European Commission Communication on a European alternative fuels strategy evaluates the main alternative fuel options available to substitute oil whilst contributing to reduce greenhouse gas (GHG) emissions from transport, and suggests a comprehensive list of measures to promote the market development of alternative fuels in Europe, complementing other policies for reducing oil consumption and GHG emissions from transport. According to the Commission, the main alternative fuel options are electricity, hydrogen, biofuels, natural gas (in the forms of Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG), or Gas-To-Liquid (GTL)), and Liquefied Petroleum Gas (LPG) (EC, 2013a).

At present, the market development of alternative fuels is still held back by technological and commercial short-comings, lack of consumer acceptance and missing adequate infrastructure. The current high cost of innovative alternative fuel applications is largely a consequence of these shortcomings. Initiatives to support alternative transport fuels exist at both EU and national level but a coherent and stable overarching strategy with an investment friendly regulatory framework needs to be put in place.

Let's now turn to an overview of the possibilities of alternative energy at the current stage and analyze the main types of alternative sources as recognized by the EU Commission.

LPG is a by-product of the hydrocarbon fuel chain and its use in transport increases resource efficiency. Currently, it derives from crude oil and natural gas and in the future possibly also from biomass. LPG is widely used in Europe, accounting for 3% of motor fuels and powering 9 million cars. LPG infrastructure is well established, with some 28,000 dispensing sites in the EU but with a very uneven distribution across the Member States. Its advantage consisting in producing low pollutant emissions, however, has been diminishing as the EURO standards have progressed to lower general emission limits. There remains, however, a clear advantage in particulate emissions. LPG might still expand its market share but will likely remain a niche market (EC, 2013a).

The next source to be considered is natural gas, which offers a long-term perspective in terms of security of supply to transport and a large potential to contribute to the diversification of transport fuels. It also offers significant environmental benefits, in particular when it is blended with biomethane and provided that fugitive emissions are minimized. Natural gas also presents an advantage in lower emissions.

Another type of natural gas is this gas in liquefied form (LNG), which with high energy density offers a cost-efficient alternative to diesel for waterborne activities (transport, offshore services, and fisheries), trucks and rail, with lower pollutant and CO_2 emissions and higher energy efficiency. LNG is particularly suited for long-distance road freight transport for which alternatives to diesel are extremely limited.

LNG is also an attractive fuel option for vessels in particular to meet the new limits for sulphur content in marine fuels decreasing from 1% to 0.1% from 1 January 2015 in Sulphur Emission Control Areas (SECAs) in the Baltic Sea, North Sea and English Channel as set by the International Maritime Organisation (IMO). These obligations will be relevant for about half of the 10,000 ships currently engaged in intra-EU shipping. LNG is an attractive economic alternative also for shipping outside SECAs, where sulphur limits will decrease from 3.5% to 0.5% from 1 January 2020, and globally (EC, 2013a).

According to the final report of North European LNG infrastructure project as of May 2012, the lack of fuelling infrastructure and common technical specifications on refueling equipment and safety regulations for bunkering hamper market uptake. LNG in shipping, on the other hand, could be economically viable, with current EU prices considerably lower than for heavy fuel oil and low sulphur marine gasoil, and prospects of increasing spreads in future (Danish Maritime Authority, 2012). Moreover, LNG development into a global commodity can improve security of energy supply in general by boosting the use of natural gas as fuel for transport.

Next type of the alternative source to be analyzed is compressed natural gas (CNG). CNG vehicles have low pollutant emissions and have therefore rapidly gained ground in urban fleets of buses, utility trucks and taxis. Optimized gas-only vehicles can have higher energy efficiency. An economically viable market development could be expected by private initiatives as CNG vehicles are competitive with conventional vehicles in price and performance, and natural gas is cheaper than petrol and diesel. But public intervention is necessary to avoid fragmented EU level markets and to enable EU-wide mobility for CNG vehicles.

Natural gas can also be transformed to a liquid fuel by first decomposing it to a "synthesis gas", consisting of hydrogen and carbon monoxide, and then by refining to a synthetic fuel with the same technical characteristics as conventional fuels, fully compatible with existing combustion engines and fuel infrastructure. Synthetic fuels can also be produced from waste feedstock. They improve the security of supply and reduce pollutant emissions of present vehicles. Moreover they promote advanced engine technologies of higher energy efficiency. High cost, however, presently limits market take-up (EC, 2013a).

Next alternative source under consideration is bioenergy. According to the European Biomass Association (AEBIOM) report as of 2014, final energy consumption of bioenergy in 2012 was 102 Mtoe, almost double that of 2000. Biomass for heat and bioheat represent 74,7 Mtoe followed by biofuels for transport at 14,6 Mtoe and biopower at 12,8 Mtoe (AEBIOM, 2014).

Biofuels are currently the most important type of alternative fuels, accounting for 4.4% in EU transport. They can contribute to a substantial reduction in overall CO_2 emissions, if they are produced sustainably and do not cause indirect land use change. They could provide clean power to all modes of transport. However, supply constraints and sustainability considerations may limit their use. Biofuels can be produced from a wide range of feedstock through technologies in constant evolution and used directly or blended with conventional fossil fuels. They include bioethanol, biomethanol and higher bioalcohols, biodiesel (fatty-acid methyl ester, FAME), pure vegetable oils, hydrotreated vegetable oils, dimethyl ether (DME), and organic compounds.

In addition to this, biofuels can serve as a renewable alternative to jet fuel in airliners but are currently not produced on a large commercial scale for this purpose. To help spur the commercial development of biofuels for aviation, the European Commission and its partners have launched the European Advanced Biofuels Flightpath (EC, 2015b).

Turning now to the legislative side of the issue, it should be noted that the EU adopted the Renewable Energy Directive and a revision of Fuel Quality Directive (FQD) in 2009 as part of the Climate and Energy Package. The Renewable Energy Directive introduced a mandatory target of 10% renewable energy in the EU transport sector. The 10% can be met through renewable electricity, hydrogen and sustainable biofuels.

However, due to the limited progress achieved under the non-binding 2003 Biofuels Directive, the objectives of renewables incorporation in transport were made mandatory. The RED determines that by 2020 Member States must meet at least 10% of the national energy demand in road transport through renewable energy sources, including biofuels (ePURE, 2015).

The second mentioned document, namely the revised Fuel Quality Directive (FQD), introduced an objective to decrease GHG emissions by all liquid fuels used in the transport sector by 6%, an objective that is expected to be met with similar amount of renewable energy required under the RED. The FQD defines the permitted level of emissions derived from fossil fuels and includes an obligatory target of 6% of GHG emission reductions in fuels, to be achieved by member states by 2020 (ePURE, 2015).

To qualify for both the RED and FQD targets, biofuels consumed in the European Union must comply and demonstrate compliance with strict sustainability criteria. They set rigorous requirements on the minimum level of greenhouse gas emissions savings, appropriate land use as well as monitoring requirements for any potential adverse effect. In particular:

- Emission savings: biofuels must provide at least 35% GHG emissions savings compared to fossil fuels, a threshold set to rise to 50% as of 2017, and to 60% as of 2018 for new installations;
- Land use: raw material must not be grown on land with high-carbon stocks (e.g. forests), of high biodiversity value (highly biodiverse grasslands), or wetlands.
- Biofuels produced within the EU must meet cross compliance environmental rules, part of the Common Agricultural Policy.

These sustainability criteria make the EU biofuel sector a front-runner in the field of sustainable production. However, their application to biofuels alone sets the industry at a competitive disadvantage and hampers its ability to develop new technologies. If the EU is serious about curbing climate change then these criteria should be expanded to all products, from fossil energy to food production and biomass for electricity (ePURE, 2015).

Moreover, in January 2014, the European Commission set out its vision for EU climate and energy policy up to 2030. Based on this Communication, the policies that have driven biofuel uptake and attempted to mitigate their consequences would be altered dramatically post 2020. One of the important statements of this document is that biofuels produced from food-based feedstocks should not receive ‘public support’ after 2020 since these biofuels do not lead to substantial greenhouse gas savings (IEEP, 2014).

According to the EEA report as of June 2013, the general target of 20% renewable energy for 2020 translates into individual targets for Member States, which range from 10% (for Malta) to 49% (for Sweden). In 2010 Member States adopted National Renewable Energy Action Plans (NREAPs), which indicate how much each bioenergy source will contribute to achieving their renewable energy targets. From these NREAPs it is apparent that bioenergy will make up more than half of all renewable energy in 2020 — implying that it will account for about 10% of the EU's total gross final energy consumption. Some Member States that have limited alternative renewable-energy options and large biomass resources significantly exceed the average EU share of biomass within their final energy consumption (EEA, 2013).

However, it should be noted that such optimistic scenarios may be unrealistic, because of a number of uncertainties that include in particular the following: the continuation of financial support to the development of biogas; the sustainability of biomass production with its impacts on ecosystems; the effect of competition on cultivated land between biomass production and food and feed production; and the issue of deforestation. Nevertheless, in the period up to 2030 – and certainly up to 2020 – biogas is likely to make a much greater contribution to European natural gas balances than unconventional gas.

Looking beyond 2020, the EU's Energy Roadmap 2050 likewise foresees a central role for bioenergy in delivering an 80–95% reduction in EU greenhouse gas emissions by 2050. Such ambitious reduction targets underline the importance of developing bioenergy in a way that enables very substantial cuts in GHG emissions and does not impact on ecological resources (EEA, 2013).

With the aforementioned targets in mind, it is evident that a range of bioenergy technologies need to be deployed over the coming years in order to meet those targets. Experts believe that biomass is likely to contribute half the 20% renewable energy target (EREC, 2014).

Turning now to the second issue under study within this section, namely the possibilities of renewable energy sources at a current stage, it is important to start with the fact that the promotion of renewable energy is a cornerstone in the EU's climate and energy strategy until 2020 as illustrated by the 20/20/20 targets for greenhouse gas reductions, energy efficiency and renewable energy sources contained in the Europe 2020 Strategy for growth and jobs (EC, 2010a).

In 2010, the renewables share in the EU was 12.7% in comparison with 8.5% in 2005. Following the introduction of indicative targets (2001-2010), the share of renewable energy grew annually by 4.5%. With legally binding national targets growth has increased but needs to average 6.3% per year to meet the overall 2020 target. The share of renewables in transport reached 4.7% in 2010 compared to only 1.2% in 2005. In the heating and cooling sector, renewable energy continues to grow and its share should nearly double by 2020. However, new measures will be needed for most Member States to achieve their 2020 targets reflecting the scaling back of support schemes and more difficult access to finance in the context of the economic crisis (EC, 2013b).

It is now worthwhile to examine the possibilities of renewable energy within the EU at a modern stage by considering major sources of this kind of energy separately, taking into account their current status and outlook for their future development.

Let’s first start with the small hydropower, defined by installed capacity of up to 10 MW. According to the European Renewable Energy Council and European Small Hydropower Association, small hydropower is the backbone of electricity production in many countries in the European Union. Hydropower technology is already highly efficient and affordable (in terms of investment cost and internal rate of return). Furthermore the technology has a long life span.

In general, most of Europe’s hydropower storage capacity is concentrated in Scandinavia, the Alps and the Pyrenees. According to the Intergovernmental Panel on Climate Change, which is the leading international body for the assessment of climate change, the undeveloped hydropower potential in Europe is 47 % of the technically feasible potential (IPCC, 2015).

The EURELECTRIC report as of 2013 provides the following key figures on hydropower in Europe (EURELECTRIC, 2013b):

Table 1.Hydropower in EU-27

	EU-27
Generation	338 TWh
Capacity	136 GW
Further generation potential	276 TWh

It is also important to mention that hydropower shows the highest energy payback ratio in comparison with all other technologies – renewables as well as conventional ones. During its lifetime a hydropower plant produces more than 200 times the energy needed to build, maintain and operate it. Reasons for the high-energy payback ratio are the very long lifetime of hydropower schemes and the short energy conversion process. Once built, hydropower infrastructure can generate electricity for many decades, often even for more than 100 years. For this reason, lifecycle assessments for hydropower generally provide a very good carbon footprint and energy efficiency profile (EURELECTRIC, 2013a).

However, on the way of hydropower further deployment in Europe there are several challenges concerning competitiveness. Capital costs are high, and payback starts late due to long permit granting procedures and construction times. Such a long permit granting procedure increases the uncertainty about the future regulatory framework, and represents a high risk at the time of the investment decision. Moreover, administrative barriers and regulatory changes during operation represent additional challenges. Grid fees can disadvantage pumped storage plants compared with other competing flexibility options. Therefore, some policy changes are still to be taken by the EU in order to fully utilize the advantages of hydropower, which would in its turn help to maintain high energy security level (EURELECTRIC, 2013a).

The next source of renewable energy to be analyzed under the framework of the issue stated in the topic of the section is photovoltaic energy. Among various renewable energy technologies today, photovoltaics (PV) attracts considerable attention due to its potential to contribute a major share of renewable energy in the future. Let us consider some recent figures. According to International Energy Agency, in Europe PV systems for a total rated power equal to17.27 GW were installed in 2012, below the 22.13 GW of 2011, bringing the PV cumulative capacity to 69.6 GW (IEA, 2015). German remains at the forefront, with 7.604 GW of installed PV power in 2012, followed by Italy (3.647 GW), France (1.079 GW), the U.K. (0.925 GW) and Greece (0.912 GW). Spain, despite impressive growth in recent years (especially 2008), is at the 3rd place in Europe for cumulative PV capacity (4.706 GW) behind Germany (32.461 GW) and Italy (16.450 GW), but its additional PV power was very low in 2012 (223 MW) (IEA, 2015).

The PV contribution to the electricity demand has surpassed 1% in several countries. Italy is in the first place, with a percentage close to 7%, which corresponds to a higher percentage of 14% referred to as peak electricity demand. Germany is in the second place, with 5.6%, followed by Greece (3.5%). In Germany, in particular, the 32.461 GW of cumulated PV capacity produces, on certain days, up to 45% of the instantaneous power demand and around 14% of the electricity during peak periods (EPIA, 2014).

The development of the PV sector in the last decade has been fuelled by the implementation of various supporting strategies, aimed at reducing the gap between the PV energy cost and the cost of energy for conventional generation. The deployment of support policies has spurred the reduction of PV energy costs, making possible, as early as 2012 and 2013, "fuel parity" in some countries. Despite this, PV is still not very competitive and its development requires adequate support mechanisms and simple grid connection procedures. In Europe PV is to a great extent supported mainly by feed-in tariffs and net-metering. The most successful examples of feed-in tariff systems in the EU can be found in Germany and Italy (IEA, 2010).

Now, let's take an outlook for the development of this type of alternative energy source in the EU framework. For 2030 to 2050, European Photovoltaic Industry Association together with European Renewable Energy Council have shown the high potential of PV within the RE-thinking 2050 scenario (EREC, 2010).

Based on the intermediate "SET For 2020" scenario, PV could reach as much a 962 GW of installed capacity by 2050 in Europe. The potential of photovoltaic electricity could, however, be at least 50 % higher in Europe by 2050. Available land area and buildings in "zero impact areas" (i.e. areas not in competition with food production, natural reserves, housing, industry or other purposes) represents a potential of more than 5,000 TWh of yearly PV electricity production (EREC, 2015).

According to the European Photovoltaic Industry Association (EPIA) global market outlook for photovoltaics 2014-2018, overall the future of the European market is uncertain for the coming years. The drastic decrease of some feed-in tariffs programs may push some markets down, with a limited number of emerging markets in Europe that could offset any major decline. Given these new conditions, the short-term prospects for the European markets are stable in the best case, and could even decline.

According to European Photovoltaic Industry Association (EPIA), it can reasonably be assumed that photovoltaic electricity will become a mainstream power source in Europe by 2020 and a major power source in 2050. The "SET for 2020" study carried out by EPIA outlines that, provided some boundary conditions are met, PV could supply up to 12% of the electricity demand in Europe by 2020, thus representing 390 GW of installed capacity and 460 TWh of electricity generation (EPIA, 2009).

Next source of alternative energy to be mentioned within the framework of possibilities of alternative energy at a current stage in the EU is geothermal energy.

According to the European Renewable Energy Council, the largest geothermal district heating systems within Europe can be found in the Paris area in France, with Austria, Germany, Hungary, Italy, Poland, Slovakia and others showing a substantial number of interesting geothermal district heating systems. Sweden, Switzerland, Germany and Austria are the leading countries in terms of market for geothermal heat pumps in Europe. Moreover, there are approximately 1000 MW of electric power (with conventional technology) installed in the EU, around the clock. However, the relevant resources are far from being fully developed, also in Europe. (EREC, 2015).

Let’s now turn to analyzing ocean energy current potential for the EU. The ocean is an enormous source of renewable energy with the potential to satisfy an important percentage of the European electricity supply. Conversion of the wave energy resource alone could supply a substantial part of the electricity demand of several European countries, in particular Ireland, the UK, Denmark, Portugal, Spain and Norway, especially on islands and in remote areas. The best ocean energy resources within the EU Member States are wave energy and marine currents, which have seen the most technological development. Salinity gradient systems are being developed in Norway and the Netherlands. Ocean thermal energy conversion technologies are not yet available in Europe but can be harvested at latitudes closer to the Equator with technologies developed by European companies.

According to the European Renewable Energy Council, over the past few years, dedicated infrastructure for wave and tidal sea trials have been created in several European countries. They facilitate deployment of technologies from prototype to commercial phase by making cable connection available and/or simplifying the licensing procedure. At present, several grid connected test areas are under development, scheduled to be operational with the coming 1 to 3 years.

Nowadays, tidal barrage is the only ocean energy technology that has been operating for decades. La Rance, France was inaugurated in 1966 and has been exploited commercially ever since. Several wave and marine current technologies are currently in (full scale) demonstration stage. Salinity gradient and OTEC are still largely in R&D stage. However, the first salinity gradient prototype installation is operational since December 2009 in Statkraft, Norway. The installed capacity in 2009 was approximately 250 MW. This included La Rance in France that has an annual production of 550 GWh (EREC, 2015).

Although ocean energy R&D started decades ago, remarkable development has only taken place since the beginning of this century. Overall, ocean energy development is no longer limited to academic research. Recently, large companies, utilities and industrial consortia have started to invest substantially in ocean energy projects demonstrating the ambition of the sector. Political engagement is being demonstrated by Member States with high ocean energy resources by means of dedicated research funding programs, support schemes and ambitious national targets (EREC, 2015).

It is also important to consider the outlook for this kind of energy for the distant future. Thus, according to the latest data provided by EREC, in terms of electricity production generated by the sector, ocean energy estimates are the following: 8.94 TWh in 2020, 150 TWh in 2030, 549 TWh in 2040 and 645 TWh in 2050. These assumptions are based on the development of offshore wind and assume saturation in 2050. In terms of cost, it has to be noted that the cost of ocean energy is very technology specific. Cost figures are still being developed as devices enter long-term energy production stage. The 2011 Carbon Trust report ‘Accelerating Marine Energy’ estimates the cost for wave energy. According to it, the current baseline costs of energy from marine devices are higher than conventional fossil fuel generation and more developed renewable energy technologies such as onshore and offshore wind. There is therefore a clear need to explore the potential for cost reduction, and to understand how this can be accelerated to make wave and tidal a cost-effective option for low carbon energy generation (The Carbon Trust, 2011).

Following the European Renewable Energy Council’s forecast, growth of the sector to 2020 is estimated by using an exponential curve that follows the growth since 1998 leading to projected installed capacity of 3,6 GW by 2020. Considering ocean energy faces similar challenges as the offshore wind sector, a similar growth curve has been used to project the 2030 and 2050 scenarios leading to a projected installed capacity of 54 GW by 2030 and 188 GW by 2050. Furthermore, it is considered highly likely that ocean energy will form synergies with offshore wind (EREC, 2015).

It should be mentioned within the framework of this issue that one of the main hindering factors for ocean energy expansion will be the availability and capacity of the offshore and coastal electrical grid. Unlike the offshore wind sector, which has been involved in the planning process for the grid expansion and development for many years, the ocean energy sector has difficulties to push in favor of its inclusion in grid development planning. Policy makers at both national and EU level have to ensure that all options for future offshore energy sources are taken into account.

According to European Ocean Energy Association (EU-OEA), there are several projects currently going on with respect to the ocean energy development. It is worthwhile to briefly mention those projects and their current status in order to see how much attention is dedicated to the development of this sector.

DTOcean is a European collaborative project funded by the European Commission under the 7th Framework Programme for Research and Development. The project aims at accelerating the industrial development of ocean energy power generation knowledge, and providing design tools for deploying the first generation of wave and tidal energy converter arrays. It gathers 18 partners from 11 countries (Ireland, Spain, United Kingdom, Germany, Portugal, France, Norway, Denmark, Sweden, Belgium and United States of America) under the coordination of the University of Edinburgh (EU-OEA, 2015).

The second important project is the Strategic Initiative for Ocean Energy (acronym SI Ocean), officially started on 23 June 2012. The project is coordinated by Ocean Energy Europe in close cooperation with 6 partners: the European Commission's Join Research Centre, the UK Carbon Trust, Portugal's Wave Energy Centre, Edinburgh University, Renewable UK and DHI. The key objectives of the project are resource assessment and identification of European hot spots for Ocean Energy as well as outlining key priorities for technology development and combining resource and technical assessment with a comprehensive policy and market analysis of the Atlantic arc countries (EU-OEA, 2015).

As we can see, the ocean energy is paid a lot of attention by the EU nowadays, which makes it one of the potential sources of alternative energy to outline future EU prospects with respect to energy security.

Last but not least wind energy should be analyzed. According to the European Commission, wind energy is one of the fastest growing energy sources. Since 2000, around one third of all installed electricity generating capacity in the EU has been wind power. The share of wind power in total electricity production in Europe was 3.7% in 2007, but with huge differences among the Member States: Germany and Spain together account for more than half of the total installed capacity in Europe. In Denmark, wind energy contributes more than 20% of the total electricity production of the country (EC, 2015a).

The wind power industry has the ambition to continue the fast growth of recent years. The sector's objective is to provide 20% of final EU electricity consumption by 2020. This can only be achieved if wind turbines can move offshore in order to profit from the more favorable wind conditions on the sea. This however requires considerable research efforts targeting in particular costs reduction of wind turbines, improved reliability and grid integration (EC, 2015a).

Following the European Wind Energy Association (EWEA) 2015 report, the most recent trends in this sector development included the following:

– 11,791.4 MW of wind power capacity (worth between €13.1bn and €18.7bn) was installed in the EU during 2014, an increase of 3.8% compared to 2013 annual installations.

- Wind power is the generating technology with the highest rate for new installations in 2014, accounting for 43.7% of total 2014 power capacity installations, 12 percentage points higher than during the previous year.
- There is now 128.8 GW of installed wind power capacity in the EU: approximately 120.6 GW onshore and just over 8 GW offshore.
- Annual installations of wind power have increased over the last 14 years, from 3.2 GW in 2000, to 11.8 GW in 2014 at a compound annual growth rate of 9.8% (EWEA, 2015).

Germany remains the EU country with the largest installed capacity followed by Spain, the UK and France. There are 15 EU countries with gigawatt-level wind power capacities installed, including two relatively new EU countries (Poland and Romania), and eight EU countries each have more than 4 GW of installed capacity (EWEA, 2015). In appendix A the data as of 2015 by the EWEA is provided and it shows how wind energy is currently incorporated into the EU energy consumption system

It is also worthwhile to refer to the recent report 21/2014 by the European Environment Agency and a consortium led by CE Delft, which investigates energy support measures and their impact on innovation in the renewable energy sector in Europe. Having considered a variety of perspectives on the renewables, the report concludes that despite growing interest in promoting renewable energy, in 2012 many support measures in Europe targeting fossil fuels and nuclear sectors were still in place, and continued to affect public budgets, constituting a burden on public budgets, because they are revenue forgone by governments. Meanwhile, the renewable support is a mix of surcharges on the energy bill of the end users, and governmental support. In the case of electricity, the former type of support prevails. Consequently, such support does not represent a burden on public budgets, but it does affect energy prices for end users, particularly when the merit order effect is not passed on to them. The report states that support for fossil fuels affects market conditions for renewable energy, but there is little evidence that the impact is significant, given the support allocated to the renewable sector (EEA, 2014).

According to the research mentioned above, countries' strategies differ when it comes to supporting fossil fuels, so the renewable sector must compete with a unique price structure for these fuels in each country. Therefore a more harmonized framework for energy taxation would be a good start for facilitating further developments in the renewable sector.

It is emphasized that there are several factors that are crucial for the innovation process in the renewable sector, namely: political will (or the lack thereof) to shift the focus onto the renewable sector, pre-existing innovation capabilities, the level of investment in research and development (R&D) for renewable technologies and renewable policy design. This has been observed in developments in

Denmark as well as in the four target countries, namely: the Czech Republic, the Netherlands, Spain and Switzerland (EEA, 2014).

To summarize the findings of this section it is worth mentioning that at the current stage of the EU existence, the EU is paying great attention to the alternative and renewable sources of energy. The analysis of the relevant trends showed that the EU is working hard towards increasing each of the alternative energy sources share in the transport sector and the share of renewables in total energy production.

The analysis showed that market development of alternative fuels should break the dependence on oil and contribute to improving the security of Europe's energy supply, support economic growth, strengthen the competitiveness of European industry, and reduce greenhouse gas emissions from transport. Biogas has been considered as a direct substitute for natural gas which can be used in many of the same applications: heat, steam, electricity generation and co-generation, the vehicle fuel market, feedstock in the chemical industry (fertilizer), and grid injection.

Therefore, the conclusion can be drawn that biogas can be considered as indigenous production and can be viewed as improving security of supply. However, even despite the optimistic scenarios and fast development of the alternative sources, it should be noted that these optimistic scenarios may be unrealistic, because of a number of uncertainties that include in particular the following: the continuation of financial support to the development of biogas; the sustainability of biomass production with its impacts on ecosystems; the effect of competition on cultivated land between biomass production and food and feed production; and the issue of deforestation. Nevertheless, the importance of alternative sources has been established clearly.

This section additionally framed the perspectives for each of the analyzed alternative and renewable energy sources with respect to the EU target for 2020, 2030 and 2050. Based on the outlook provided by specialized organizations and analysis of current trends, it can be concluded that the EU seems to be able to meet the set objectives by the year of 2020 as well as move towards the more ambitious targets set for the distant future.

3. POTENTIAL OF EU ENERGY POLICY TO TACKLE ENERGY SECURITY PROBLEMS

3.1 EVOLUTION OF ENERGY POLICY

From the very beginning, the EU energy policy has been about joining forces to achieve particular purposes and these particular purposes have evolved over time. In order to truly appreciate European integration development, it is crucial to understand the role energy has played and has still the potential for throughout more than 50 years history of this process.

Indeed, it is hardly possible to explain the origins of the European Union without considering what happened in Europe just after the end of World War II. Starting with the establishment of the European Coal Organization in 1946 and then the Organization for European Economic Cooperation in 1948, energy was a cornerstone of European integration.

The rationale for establishing the first Community organization in 1951, the European Coal and Steel Community (ECSC), lay explicitly with the energy-related challenges that Europe had to face during those years. A similar motivation lay behind the creation of the European Atomic Energy Community (EUROATOM) in 1957, with both the latter and the ECSC constituting the basic pillars of the European Economic Community (Morata and Sandoval, 2012).

Thus, it is accurate to argue that energy is not only deeply rooted in European construction, but that it has been in itself – with more or less success – a driver of integration. The early development of the EU energy policy is described in some more details below.

In 1951, in the aftermath of the World War II, the European Coal and Steel Community was created in order to pool the production of coal and steel in the Member States (France, West Germany, Belgium, Netherlands, Luxembourg, Italy), ensuring that these commodities, essential for industrial development, would be available to all. The purpose was strongly political as well as economic. The pooling of production would make war between the members as stated in the Schuman Declaration "not merely unthinkable, but materially impossible" (Fontaine, 2000).

Later in the 1950's, in a context of rising energy demand in Europe, depletion of easily accessible coal and concern about growing dependence on oil imports (1956 Suez Crisis), nuclear energy seemed promising as a new element in the energy supply mix. This was a time of Cold War and nuclear weapons research so nuclear energy development needed to be kept clearly separate from weapons development. In 1957, Member States created the European Atomic Energy Community (EURATOM), a supranational control system for fissile materials, also safety standards and a framework for cooperation on the development of nuclear energy (IIEA, 2015).

Despite the fact that two of the founding treaties of the European Communities were concerned with energy, EU activity in energy policy is a relative novelty and essentially only relatively recently started with the paradigmatic shift of energy regulation in Europe and the start of the liberalization process in the 1990s (Renner, 2009).

The next period in the evolution of the EU energy policy can be named as first serious challenges to overcome. When oil crises loomed in the late 1960's, the provisions in the European Community for dealing with supply difficulties in general were brought into play. All Member States committed to building up oil stocks and using them in a coordinated way in crises. Over the next years, Member States went on to agree common energy policy objectives, still much influenced by energy security concerns - rational use of energy, development of domestic resources, diversification of supplies (IIEA, 2015).

The 1973 oil-crisis revealed the weaknesses of Europe's energy policies, which increased cooperation somewhat by the formation of the International Energy Agency (IEA). However, it was not until the 1986 Single European Act that the economic importance of energy was acknowledged within the European integration process. Decision-makers realized that a freer European energy market was necessary for a functioning Single Market. The first real breakthrough in integrating national energy policies was established by the Maastricht Treaty, where the EU set out on a course of liberalization of the European electricity and gas markets. Yet, at the turn of the century the liberalization process had slowed down significantly because of changes in the international energy market (Eriksson, 2011).

In the 1980's, energy was brought into the renewed push to establish a single European market. Competition in the provision of services which had traditionally been offered as public utilities was expected to yield benefits to consumers. Concerns about fossil fuel supplies had diminished by this time, global prices were dropping, North Sea oil and gas was coming on stream and in electricity generation, Combined Cycle Gas Turbine technology was providing a competitive new option. Liberalization and competition in Europe should bring new market players, innovation and lower prices for consumers. With enough interconnections, a single energy market should also strengthen cohesion and security of supply. Legislation to create a single energy market has been adopted gradually from 1996 (Eriksson, 2011).

Several opinions of various researchers in the field of energy economics on the development of energy policy within the European area are worth being mentioned here. Thus, according to Buchan, the development of a European energy policy can instead be viewed as an organic process, a slow progress often running ahead of treaty clauses (Buchan, 2009). McGowan argues that along the early development of the European energy policy, policymakers mainly used legal competences from the economic and environmental parts of the treaties in order to push for common energy initiatives (McGowan, 1996). Andersen, for instance, means that the Commission's ability to introduce energy initiatives "from the side", made it the main driver for a common energy policy (Andersen, 2001).

The 1990's had offered favorable conditions for member states to support the Commission's market-oriented approach, through low energy prices, plentiful of European oil and gas reserves and healthy competition between several energy exporting countries, and gave confidence to the market's ability to ensure reasonable energy prices and security of supply (Eriksson, 2011).

During this time, new objectives for EU energy policy were agreed. In 1990, Europe made a clear political commitment to the global climate challenge and followed up with targets and strategies for greenhouse gas emissions reduction. The need for a transition to an efficient, low-carbon energy system became quickly clear, the issue was how best to achieve it. Energy efficiency gains and fuel switching were essential. Community instruments such as standards, R&D and others, were brought into service. However, there was not enough political support for a 1991 CO_2/energy tax (Eriksson, 2011).

Generally speaking, until 1997 most European Member States kept monopolistic structures in energy supply and distribution at least for their domestic energy carriers. In Eastern European countries, until 1989 the dominating principle was central planning in economy, which for energy supply meant increasing the absolute amount of energy generated, immaterial of the related cost. Transparency on real cost of supply was in most cases not given, as both final energy prices, cost of labor, and mostly also investment cost were subject to political steering. When looking at the role which certain energy carriers played in the historical setup in many European countries, it becomes evident that mainly hard coal and from the 1960s onwards also nuclear stood in the focus of policy induced strategies still ranking strategic security of supply higher than least cost options (EC, 2014c).

After the 1997 Kyoto Protocol, the Emissions Trading System was created in 2005 as a means of putting a price on carbon emissions. In 2007, 2020 targets were agreed for greenhouse gas emissions, renewables and energy efficiency (EC, 2012).

When investigating the recent development more thoroughly, it can be seen that during the beginning of the 21st century the situation of the European energy markets has changed dramatically.

First, European oil and gas reserves were quickly depleting, while investment in energy infrastructure decreased and energy consumption grew, making EU increasingly dependent on energy imports (Umbach, 2010). As a result, energy has increasingly been identified as a security issue within the EU. High and volatile oil prices and growing energy demand coupled with increasingly unreliable supply of energy made Europe consider energy supply and sustainability in terms of security. The partial success of pushing towards more liberalized European energy markets and the optimism of a common energy policy were soon replaced by a time of vulnerability and instability in the European energy markets (Eriksson, 2011).

Secondly, the post-9/11 effects and the increasingly troublesome political situation in many supply countries increased the instability of the international energy market. Simultaneously new dominant economies such as China and India emerged and increased the global demand of energy supplies significantly. The international energy market experienced a structural shift from a "buyers‟ market", where suppliers compete for buyers, to a "sellers‟ market", where buyers compete for suppliers. The new situation on the international energy market made energy prices grow and the EU's dependence on third countries for energy supplies increased (Eriksson, 2011).

Simultaneously, climate change became one of the most urgent issues on the political agenda, making sustainability of energy production a growing security issue for Europe. Energy and environmental policies are inextricably linked, since all energy production and consumption has environmental impacts. Considering the fact that energy is one of the most polluting sectors of the European economy, the need for an integrated energy and climate policy became increasingly urgent. Therefore, let's now turn to a brief overview of the EU environmental policy within the framework of the energy policy of the Union.

In many regards energy and environmental objectives go hand in hand. First to be mentioned is energy efficiency and reducing energy use issues. Saving energy can help avoid impacts associated with extractive industries and with energy generation, transformation, distribution and consumption in general. It can also help reducing GHG emissions, air pollution, impacts to surface and ground waters, habitat fragmentation and biodiversity disturbance through infrastructure and land use, etc. The EU has put forward several measures to improve efficiency at all stages of the energy chain and it is aiming for a 20% cut in Europe's annual primary energy consumption by 2020. Moreover, at an EU summit in October 2014, the EU countries agreed on a new energy efficiency target of 27% or greater by 2030. What is more, the European Commission had proposed 30% in its Energy Efficiency Communication (EC, 2014d).

Over the past decades the European Union has put in place a broad range of environmental legislation. As a result, air, water and soil pollution has significantly been reduced. Chemicals legislation has been modernized and the use of many toxic or hazardous substances has been restricted. Today, EU citizens enjoy some of the best water quality in the world and over 18% of EU's territory has been designated as protected areas for nature. However, many challenges persist and these must be tackled together in a structured way (EC, 2014e).

The 7th Environment Action Programme (EAP) will be guiding European environment policy until 2020. In order to give more long-term direction it sets out a vision beyond that, of where it wants the Union to be by 2050. The programme identifies three priority areas where more action is needed to protect nature and strengthen ecological resilience, boost resource-efficient, low-carbon growth, and reduce threats to human health and wellbeing linked to pollution, chemical substances, and the impacts of climate change (EC, 2014e).

The first action area is linked to "natural capital" – from fertile soil and productive land and seas to fresh water and clean air – as well as the biodiversity that supports it. Natural capital includes vital services such as pollination of plants, natural protection against flooding, and the regulation of our climate. The Union has made commitments to halt biodiversity loss and achieve good status for Europe's waters and marine environment. Moreover, it has put in place the means to achieve this, with legally-binding commitments including the Water Framework Directive, the Air Quality Directive, and the Habitats and Birds Directives, together with financial and technical support.

The second action area concerns the conditions that will help transform the EU into a resource-efficient, low-carbon economy and is closely linked to 2020 targets set by the EU. The third key action area covers challenges to human health and wellbeing, such as air and water pollution, excessive noise, and toxic chemicals (EC, 2014e).

It is noteworthy to consider several particular environmentally related policies of the EU. First is EU excise duty, which rules cover all energy products used for heating and transport, as well as electricity. The primary goal of EU energy tax legislation is to ensure that the Single Market runs smoothly and to prevent distortions in competition and trade within the EU. In addition, energy taxation can play an important role in achieving wider EU goals. In particular, it can help achieve Europe's objective of becoming a competitive, low-carbon and energy efficient economy.

Current EU rules for taxing energy products and electricity are laid down in the Energy Tax Directive 2003/96/EC, which entered into force on 1 January 2004. This Directive includes: a common EU framework for taxing motor fuels, heating fuels and electricity; minimum rates for energy products used as motor or heating fuel; minimum rates for commercial and industrial purposes, such as agriculture, stationary motors and machinery used in construction and public works; some options for exemptions for use of energy products and electricity; special provisions for commercial diesel, and finally, out of the scope provisions for energy products and electricity. The aim of this legislation is to reduce distortions caused by divergent national tax rates, remove competitive distortions between mineral oils and other (unlegislated) energy products, and create incentives for energy-efficiency and emission reductions (EC, 2003).

In 2011, the Commission presented a proposal to revise the Energy Tax Directive. The aim of the proposal was to modernize EU rules on energy taxation. It seeks to restructure the taxation of energy products, in order to remove current imbalances and distortions, and support the EU's wider environmental and energy goals. A key feature of the proposal is to tax energy in a way that reflects both its CO_2 emissions and its energy content. Energy taxes would be split into these two components to determine the overall rate at which the fuel is taxed. The proposal also makes a distinction between sectors covered by the EU ETS and those that are not, to avoid double taxation. The proposal is still under discussion by Member States in Council (EC, 2011).

Secondly, carbon capture and geological storage (CCS) is worth mentioning. CCS is a technique for trapping carbon dioxide emitted from large point sources such as power plants, compressing it, and transporting it to a suitable storage site where it is injected into the ground. This technology has significant potential to help mitigate climate change both in Europe and internationally, particularly in countries with large reserves of fossil fuels and a fast-increasing energy demand.

The biggest challenge related to this policy is the fact that the cost of capture and storage remains an important barrier to the take-up of CCS. The capture component in particular is an expensive part of the process. As flue gas from coal or gas-fired power plants contains relatively low concentrations of CO2 (10-12% for coal and around 3-6% for gas), the amount of energy needed to capture the gas makes the process costly (EC, 2015c).

It is important to highlight that the Commission's proposal for a 2030 climate and energy policy framework acknowledges the role of CCS in reaching the EU's long-term emissions reduction goal. According to the 2030 framework, in the power sector, CCS could be a key technology for fossil fuel-based generation and it could help balance an electricity system with increasing shares of variable renewable energy (EC, 2013c). However, it should be emphasized that in order to ensure that CCS can be deployed in the 2030 timeframe, increased R&D efforts and commercial demonstration are essential over the next decade. A supportive EU framework will be necessary through continued and strengthened use of auctioning revenues.

Next environmental policy is related to clean air. Air quality is an area in which the European Union has been very active. Since the early 1970s, the EU has been working to improve air quality by controlling emissions of harmful substances into the atmosphere, improving fuel quality, and by integrating environmental protection requirements into the transport and energy sectors. As the result, much progress has been made in tackling air pollutants such as sulphur dioxide, lead, nitrogen oxides, carbon monoxide and benzene. However, as outlined above, and despite the progress made, air quality continues to cause serious and avoidable problems.

The European Commission has recently carried out a comprehensive review of existing EU air policy in 2011-2013, building on the 2005 Thematic Strategy on Air Pollution (EC, 2005). Drawing on the conclusions from this review, the Commission has adopted a Clean Air Policy Package in December 2013, consisting of A new Clean Air Programme for Europe with new air quality objectives for the period up to 2030, a revised National Emission Ceilings Directive with stricter national emission ceilings for the six main pollutants, and a proposal for a new Directive to reduce pollution from medium-sized combustion installations.

European legislation on air quality is built on certain principles. The first of these is that the Member States divide their territory into a number of zones and agglomerations, where the Member States should undertake assessments of air pollution levels using measurements and modeling and other empirical techniques. Where levels are elevated, countries should prepare an air quality plan or program to ensure compliance with the limit value before the date when the limit value formally enters into force. In addition, information on air quality should be disseminated to the public (EC, 2013d).

Last but not least to be mentioned is the fact that the European Union has long been committed to international efforts to tackle climate change and felt the duty to set an example through robust policy-making at home. At European level a comprehensive package of policy measures to reduce greenhouse gas emissions has been initiated through the European Climate Change Programme (ECCP). Each of the EU Member States has also put in place its own domestic actions that build on the ECCP measures or complement them (EC, 2014e).

Thus as the single energy market was being gradually put in place, the purpose of EU energy policy and the role expected of the market was changing. EU energy policy is now gearing up to a long-term transition to a secure, efficient, low-carbon energy system. The market should facilitate cost-effective development of the varied resources in Europe – natural, technical, industrial – which will together make up the transition. The focus has shifted from specific support schemes to market integration of early movers, new technologies, and more broadly, to how different resources, players and policies interact, positively and negatively, in the market (IIEA, 2015).

Limited availability of internal energy resources and growing energy consumption has made the EU increasingly dependent on energy imports. Simultaneously, the limited ability of the atmosphere to withstand increased GHG emissions have put further pressure to develop a sustainable European energy sector (Müller-Kraener, 2008). Energy security has emerged as the primary challenge for Europe's energy policy.

Having considered the framework of how the EU energy policy evolved and according to what conditions it modified, let's now analyze the most recent trends of the EU energy policy. The goals of the EU energy policy were defined by the Council of the European Union and are as follows:

- increasing security of supply;
- ensuring the competitiveness of EU economies and the availability of affordable energy;
- promoting environmental sustainability and combating climate change (EC, 2007a).

Energy policy is no longer a matter exclusive to the national administrations, as nowadays Brussels performs an active, although still limited, role in this field.

This transition in the governance of energy policy in Europe is reflected in chapter 4 of the Treaty on the Functioning of the European Union (TFEU), where energy appears as a 'shared competence' between the EU and its member states – as in the case of the internal market, the environment and the trans-European networks (Morata and Sandoval, 2012). This effort to better coordinate actions in the energy field is reflected in art. 194 of the TFEU on energy, which argues as follows:

"In the context of the establishment and functioning of the internal market and with regard for the need to preserve and improve the environment, Union policy on energy shall aim, in a spirit of solidarity between Member States, to: (a) ensure the functioning of the energy market; (b) ensure security of energy supply in the Union; (c) promote energy efficiency and energy saving and the development of new and renewable forms of energy; and (d) promote the interconnection of energy networks." (art. 194.1, TFEU, 2007)

In spite of the current financial and economic crisis, the energy policy area remains one of the key concerns both at European and national levels. Since energy is the 'blood' of modern societies and the whole economic and social well-being of the European peoples and European industry relies on safe, secure, sustainable and affordable energy, there are those in Europe who argue that energy policy is to be 'the next great European integration project' (EC, 2010b). The pressing importance of current challenges such as climate change and energy security has made the creation of European energy policy an essential pre-requisite for the construction of the Europe of the twenty-first-century, and the European institutions have therefore called for a ‘revolution in the energy systems’ to face the challenging global context that hastens the decarbonization of the European economy (Morata and Sandoval, 2012, p.4).

It was not until March 2007 that the EU heads of state and governments endorsed the first EU “energy action plan”. Following a series of discussions over the previous years, the Commission’s “An energy policy for Europe” strategy marks the beginning of a more integrated European energy policy, which gained considerable momentum since then. The action plan laid out the three major challenges for European energy policy, which form the core of the common energy policy till today: sustainability, security of supply, and competitiveness. In order to reach these goals the commission also laid out quantifiable targets. In its “action plan 2007-2009” the Council adopted many of the Commission's proposals, among them the famous “20/20/20” targets, which defined European energy policy in recent years. These targets refer to three 20% goals, to be reached until 2020 include the following. Firstly, a reduction in EU greenhouse gas emissions of at least 20% below 1990 levels (to be increased to 30% in the event that other industrial countries and economically more advanced developing countries also contribute adequately). Secondly, a 20% of EU energy consumption to come from renewable resources. Thirdly, a 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency (EC, 2010a).

The plan included a range of other working areas, most prominently the completion of the internal market for gas and electricity, issues concerning security of supply, internal energy policies and energy technologies. The Council invited the Commission to come forward with proposals in order to regulate the respective areas (Langsdorf, 2011).

The action plan was complemented with changes in EU legislation shortly afterwards: the Lisbon Treaty finally included a title on energy. The article 12 first refers to the “functioning of the internal market” sticking to its roots, but then enumerates several innovations (Langsdorf, 2011). Firstly, to ensure the functioning of the energy market. Secondly, to ensure security of energy supply in the Union. Thirdly, to promote energy efficiency and energy saving and the development of new and renewable forms of energy. Last but not least, to promote the interconnection of energy networks.

There have been targets set already for 2030 and 2050, which will be considered in the following section. To summarize this section, the EU has already passed a long way on making its energy policy secure and diverse and continues doing it now as well, which is further studied in the next section.

3.2 NEW TRENDS IN EU ENERGY POLICY

While the sustainability of Europe's energy sector has become urgent issues for the EU, the increasing import dependency has gained increased attention in the EU. The EU is the world's third largest energy consumer (Eriksson, 2011) and the primary energy consumption is gradually growing as evidenced in the previous sections. As of 2014, more than half (53.4 %) of the EU-28's gross inland energy consumption in 2012 came from imported sources (Eurostat, 2014b).

Security of energy supply means ensuring continuous and adequate supplies of energy from all sources to all users. For fossil fuels, the International Energy Agency projects an increasing EU reliance on imported oil from around 80% today to more than 90% by 2035. Similarly, gas import dependency is expected to rise from 60% to more than 80%. Rising demand for energy at global scale and insufficient competition in EU energy markets has sustained high commodity prices. In 2012, Europe's oil and gas import bill amounted to more than €400 billion representing some 3.1 % of EU GDP compared to around €180 billion on average in the period 1990-2011. This increases the EU's vulnerability to supply and energy price shocks (EC, 2014f).

The origin of EU-28 energy imports has changed somewhat in recent years, as Russia has maintained its position as the main supplier of crude oil and natural gas and emerged as the leading supplier of solid fuels. In 2012, some 33.7% of the EU-28's imports of crude oil were from Russia, slightly below the shares recorded for 2010 (34.7%) and 2011 (34.8%). Russia became the principal supplier of solid fuels in 2006, overtaking South Africa, having overtaken Australia in 2004 and Colombia in 2002. Russia's share of EU-28 solid fuels imports rose from 13.1% in 2002 to 30% by 2009, before falling somewhat to 25.9% by 2012. Despite this contraction, Russia remained the primary source of solid fuels imports into the EU in 2012, although its share was only slightly ahead of those recorded for Colombia (23.7%) and the United States (23%). By contrast, Russia's share of EU-28 imports of natural gas declined from 45.2% to 29.5% between 2002 and 2010, but this trend was reversed with increases in 2011 and 2012. Qatar's share of EU-28 imports of natural gas rose from less than 1% in 2002 to 11% in 2011, before dropping back to 8.4% in 2012 (Eurostat, 2014b).

The EU's import dependence is not in itself a security issue, since a steady supply of energy could be achieved from energy exporting countries. However, the worrying political developments in many energy rich countries, with the exception of Norway, have made several energy exporting countries unreliable and unpredictable sources of energy supplies. Political, economical and ethnical conflicts in energy exporting countries may cause supply interruptions to Europe and hamper necessary investments in energy infrastructure. Energy industries in most exporting countries are subject to extensive governmental control which adds to the fear that energy can increasingly be used as a political weapon (Eriksson, 2011). Therefore, now the main issue of security of energy supply is clearly not availability, but reliability and stability of supply.

The security of the EU's primary energy supplies may be threatened if a high proportion of imports are concentrated among relatively few partners. More than three quarters (76.8%) of the EU-28's imports of natural gas in 2012 came from Russia, Norway or Algeria — as such there was a greater concentration of imports than in the previous two years as the same three countries accounted for 71% of natural gas imports in 2010 and 72% in 2011. A similar analysis shows that 53.6% of EU-28 crude oil imports came from Russia, Norway and Saudi Arabia in 2012, while 72.6% of hard coal imports were from Russia, Colombia and the United States. Although their import volumes remain relatively small, there was some evidence of new partner countries emerging between 2002 and 2012. This was notably the case for crude oil imports from Nigeria, Azerbaijan and Kazakhstan, or natural gas imports from Qatar (Eurostat, 2014b).

The political developments in Russia towards a more authoritarian political system have strained the EU's relation with its main energy supplier. Gazprom, the Russian state-owned gas company, is today the dominating actor on the European gas market and has become an important tool in Russia's foreign policy. European policy-makers have become increasingly critical to Gazprom's dominance on the European gas market, pushing diversifying European energy imports (Eriksson, 2011).

Simultaneously, the unstable situation in the Middle East has increased the instability of the international energy market. Consequently, the Middle East and North African regions have increasingly been considered unreliable energy suppliers. Import dependence of energy supplies is clearly one of the most urgent security issues, as declared by the EU in its European Security Strategy (EC, 2014a). However, import dependency does not alone constitute the EU's vulnerability to energy shortages or energy crises.

Therefore, the new trends in the EU energy policy are inevitably related to the diversification of energy sources and strengthening energy security of the Community. Consequently, the European energy strategy is based on the three core pillars (EC, 2007b):

- sustainability, to be achieved through actions including the development of competitive renewable energy sources, the diffusion of alternative transport fuels, the curbing of energy demand within Europe, the development of global actions to halt climate change and improve local air quality;

- security of supplies, that means tackling EU's rising dependence on imported energy through integrated approaches. Possible approaches includes the promotion of demand reduction, the support for growing diversification of EU's energy mix, with greater use of indigenous and renewable energy sources, the geographical differentiation of importers, the promotion of investments in energy-efficient technologies;

- competitiveness, implying the promotion of a functional, open and competitive internal energy market in order to allow improvements in the efficiency of energy grids, a decrease in energy prices, an increase in investments in clean energy production and energy efficiency, an overall improvement of EU economy in the global scenario.

Based on these European energy strategy objectives, which define the current development of the energy sector, it is important to refer to the 20/20/20 strategy once more within the framework of this section.

The EU seeks to have a 20 % share of its gross final energy consumption from renewable sources by 2020; this target is distributed between the Member States with national action plans designed to plot a pathway for the development of renewable energies in each Member State. Figure B1 in appendix B shows the latest data available for the share of renewable energies in gross final energy consumption and the targets that have been set for each country for 2020. The share of renewables in gross final energy consumption stood at 14.1 % in the EU-28 in 2012 (Eurostat, 2014a).

Thus, with the help of the graph B1, it is possible to assess new trends in the EU energy policy, as stated in the title of the section, taking future goals into account. As can be seen, Scandinavian countries are the most active and successful in implementing the use of renewables and reaching their 2020 targets.

According to the Eurostat Press Release as of March 2014, among the EU Member States, the highest share of renewables in gross final energy consumption in 2012 was recorded in Sweden (51%), while Latvia, Finland and Austria each reported that more than 30% of their final energy consumption was derived from renewables. Compared with the most recent data available for 2012, the targets for the Netherlands and the United Kingdom require each of these Member States to increase their share of renewables in final energy consumption by at least 10 percentage points. By contrast, Denmark, Sweden, Bulgaria and Estonia had already surpassed their targets for 2020 (Eurostat, 2014c).

It can be highlighted that after a period up to 2010 during which renewables were growing strongly, the combined effect of warm weather, slower progress by Member States in implementing the Renewable Energy Directive and Europe's faltering economic situation led to a decrease in the use of renewable energy in 2011. However, the share of renewable sources in gross final consumption of energy did increase, since the consumption of fossil fuel energy fell more than that of renewables. In 2012 the share of energy from renewable sources increased again and reached 14.3% and increased further to 15% in 2013 (Eurostat, 2015a).

In this perspective, the European Energy 2020 strategy focuses on five priorities that are defined as follows (EC, 2014a).

Firstly, the main objective is achieving an energy-efficient Europe. Efforts to improve energy efficiency should consider the whole energy chain, from energy generation and transformation to distribution and consumption. Energy efficiency may be supported through technical innovations and investments, and it also concerns the empowerment of domestic and business consumers, their involvement in sustainable choices concerning energy savings, reduction of wastages and the switching to low-carbon technologies and fuels. Market instruments as emissions trading systems and taxation systems may be of great help in this framework.

The second main priority is promoting a truly European integrated energy market. The hypothesis is that an integrated, interconnected and competitive market will lead to improvements in efficiency. Currently, Europe is largely fragmented into separate national energy markets characterized by monopoly or oligopoly.

In order to promote market integration, the Commission has identified 12 priority corridors and areas, and 248 key energy infrastructure projects concerning energy transport networks. Specific emphasis is posed on the Southern Gas Corridor, as natural gas will probably continue to play a key role in the EU's energy mix in the coming years and gas can also gain importance as the back-up fuel for variable electricity generation. At the same time, smart meters and power grids are crucial for promoting renewable energies, energy savings and improvements in energy services (Eriksson, 2012).

Finally, construction of new interconnections at Europe's borders should receive the same attention and policies as intra-EU projects in order to ensure the stability and security of supplies.

The third objective is empowering consumers and achieving the highest level of safety and security. It is crucial to guarantee trust, protect consumers and to help them play an active role. As energy, in particular electricity, constitutes a substantial part of the total production costs of key European industries, it is crucial to provide affordable but cost-reflective and reliable supplies.

Promoting cooperation, competition and common regulation between Member States can also contribute to diversification of supply sources. The internal market is also hampered when Member States are not fully interlinked, such as in the Baltic States. Energy policy is also responsible for protecting European citizens from the risks of energy production and transport. For example, a controversial topic is nuclear power: currently, mainstream EU position is that Europe must continue to be a world leader in developing systems for safe nuclear power, the transport of radioactive substances, as well as the management of nuclear waste (MILESECURE-2050, 2013).

International collaboration on nuclear safeguards plays a major role in ensuring nuclear security and establishing a solid and robust non-proliferation regime. In the oil and gas exploitation and conversion sector, the EU legislative framework should guarantee the highest level of safety and an unequivocal liability regime for oil and gas installations.

The fourth priority is defined as extending Europe's leadership in energy technology and innovation. Decarbonization is strictly connected to technological shifts. New technologies will reach markets more quickly and more economically if they are developed through collaboration at the EU level. Europe-wide planning and management is therefore paramount for investment stability, business confidence and policy coherence. The Strategic Energy Technology (SET) Plan sets out a medium-term strategy.

Main technologies to be developed concerns second-generation biofuels, smart grids, smart cities and intelligent networks, Carbon Capture and Storage, electricity storage and electro-mobility, next-generation nuclear, renewable heating and cooling. The resources required in the next two decades for the development of these technologies are very significant, especially when seen in the context of the current economic crisis. The EU is facing fierce competition in international technology markets; countries such as China, Japan, South Korea and the USA are pursuing an ambitious industrial strategy in solar, wind and nuclear markets (EC, 2010b).

Last but not least, the fifth priority is strengthening the external dimension of the EU energy market. As emphasized in the Communication "The EU Energy Policy: Engaging with Partners beyond Our Borders", the Commission supports intergovernmental energy agreements between Member States and third countries in order to pursue security of supply, competitiveness and sustainability (EC, 2010b). Both relations with producing and transit countries, and relations with large energy consuming countries developing countries are of great importance. The EU already has a series of complementary and targeted frameworks ranging from specific energy provisions in bilateral agreements with third countries (Free Trade Agreements, Partnership and Cooperation Agreements, Association Agreements, etc.) and Memoranda of Understanding on energy cooperation, through to multilateral Treaties such as the Energy Community Treaty and participation in the Energy Charter Treaty. At the same time, more effective coordination at EU and Member State level is needed. Of course, the external dimension of

EU energy policy must be coherent with other external dimensions concerning development, trade, climate and biodiversity, enlargement, Common Foreign and Security Policy, etc (EC, 2010b)..

The main place in the current trends of the EU energy policy is devoted to renewable energy policy and its role in reaching the goals of energy security and sustainability. The existing EU energy and environmental policy package includes numerous strategies, directives and regulations. The most significant of which are:

- Europe 2020 - a strategy for smart, sustainable and inclusive growth;
- A Roadmap for moving to a competitive low carbon economy in 2050;
- EU Emissions trading system; the security of supply directive;
- the third internal energy market package;
- renewable energy directive, the energy efficiency directive and carbon capture and geological storage directive.

Recently, a number of proposals relating to the EU energy sector have been put forward, including: a trans-European energy infrastructure regulation, the connecting Europe facility and guidance to Member States on state intervention in electricity markets. To increase the use of energy from renewable sources is among the main objectives of EU energy policy. To develop renewable sector as well as to meet the energy objectives established in the Europe 2020 Energy strategy and in the Roadmap 2050, the EC adopted the directive 2009/28/EC focusing on the promotion of the use of energy from renewable energy sources. The directive 2009/28/EC approved mandatory targets of a 20% share of energy from renewable sources in overall EU energy consumption by 2020 and a 10% target for each Member State regarding the share of renewable energy consumption in transport by 2020, which was already mentioned earlier (EREC, 2013).

It must be emphasized that to access the grid is essential for renewable power plants. Therefore, the directive 2009/28/EC requires that transmission system operators and distribution system operators all over the EU guarantee the transmission and distribution of electricity produced from RES. When dispatching electricity, transmission system operators are to give priority to installations using RES so far as the secure operation of the national electricity system allows it.

Additionally, steps towards the development of infrastructure for energy transmission and distribution, smart grids and storage facilities must be taken, so as to facilitate a secure operation of the electricity system as it integrates electricity production from RES.

In addition, the directive establishes cooperation mechanisms by which Member States can join together to develop RES. Using such mechanisms aims at overcoming national approaches towards a joint European perspective to the development of renewable energy. They include:

1) statistical transfers whereby one Member State with a surplus of renewable energy can sell it statistically to another Member State, whose renewable energy sources may be more expensive. One Member State gains a revenue, at least covering the cost of developing the energy, the other gains a contribution towards its target at lower cost;
2) joint projects whereby a new renewable energy project in one Member State can be co-financed by another Member State and the production shared statistically between the two. Joint projects can also occur between a Member State and a third country, if the electricity produced is imported into the EU, (e.g. from North Africa);
3) joint support schemes whereby two or more Member States agree to harmonize all or part of their support schemes for developing renewable energy, to clearly integrate the energy into the single market, and share out the production according to a rule (EC, 2011b).

It should be highlighted that the Renewable Energy Directive also proposed to translate the EU 20% target into individual targets for each Member State. As a consequence, binding national targets for RES shares over final energy consumption have been introduced in each Member State. Moreover, to ensure that the mandatory national overall targets are achieved, Member States established National Renewable Energy Action Plans (NREAP) as well.

Moreover, the most Member States have experienced significant growth in renewable energy. Austria, Finland, Latvia, Sweden have the highest share of renewables in their energy mix, between 30% and 45%; Denmark, Estonia, Lithuania, Portugal, Romania showing the penetration of renewable in total energy mix between 20% and 25%. Conversely, Belgium, Cyprus, Ireland, Luxembourg, Netherlands and United Kingdom have the lowest share of renewables in energy consumption (3-4%), while it is 0.4% for Malta (IEA, 2011).

In spite of the fact that Member States have experienced growth in renewable energy, based on a variety of studies (EC, 2013; EREC, 2013) the achievement of the ambitious 2020 and 2050 RES targets, however, is still hindered by numerous barriers, which should be mentioned within the scope of analysis in this section.

Firstly, there are some economic and market barriers, which mean that RES not cost-competitive under current market conditions: high capital costs, unfavorable market pricing rules, subsidies for competing fuels, long reinvestment cycles of building-integrated technologies, etc. Secondly, there are a number of legal barriers, including inefficient administrative procedures such as high number of authorities involved, lack of coordination among authorities, lack of transparent procedures, long lead times, high costs for applicants. Thirdly, infrastructural and grid-related barriers (mainly power grids, but also gas and district heat) meaning that grid access is difficult to obtain, lack of available grid capacity). Fourthly, lack of skilled labor is also important issue (e.g. for planning and installation), it also includes problems with the guarantee and warranty and maintenance regime; lack or shortcomings of certification schemes for installers.

Moreover, there are information and social acceptance barriers such as lack of knowledge (about benefits of RES, about available support measures); lack of acceptance (opposition to RES plants and power lines, public concerns about sustainability of biofuels). Finally, the economic instability - the changed economic climate has clearly an impact (fully or partially) on the development of new renewable energy projects and national renewable energy action plans commitments are also important issues nowadays.

It is also worthwhile to refer again to the report prepared by the European Environment Agency and a consortium led by CE Delft as of 2014, which concludes on current measures taken with respect to innovation in the renewables sector. According to the report, fossil fuel support seems to mostly take the form of fiscal exemptions and allowances to certain users of fossil fuels. In countries that mine fossil fuels, specific grants for the use of these resources also apply (e.g. coal in the Czech Republic, Poland, Romania, Slovakia and Spain), lignite (Germany and Slovenia), oil (Norway) or natural gas (the Netherlands and Norway). Because support for fossil fuels mainly takes the form of tax exemptions, it represents revenue forgone by governments, and therefore has an impact on public budgets. Fossil fuel support in Europe is mostly oriented towards consumption.

Meanwhile, the support for renewable energy is a mix of surcharges on end-users' energy bills and governmental support. For renewable electricity, the main policy tool is a FIT/FIP or a quota obligation which, in most cases, is financed through a surcharge on electricity bills. As such, support for renewable electricity is mainly oriented towards production, and does not place a burden on the public budget but rather on the final consumer. However, there is an exception here, namely the Czech Republic, where one third is paid from the state budget. Were the merit order effect to be passed on to the end consumer, the net effect on the electricity bill could be lowered. For renewable heat, however, support is more diversified, with investment support and grants being applied together with FITs/FIPs, so as to increase small-scale renewable heat uptake in buildings. This support is usually allocated from the government's (national or regional) budget or EU structural funds, and therefore could represent a burden on the public budget (EEA, 2014).

It is also important to consider the most recent trends of the EU energy policy, which are directed into the long term future.

First to be mentioned is that the EU countries have agreed on a new 2030 Framework for climate and energy, including EU-wide targets and policy objectives for the period between 2020 and 2030. These targets aim to help the EU achieve a more competitive, secure and sustainable energy system and to meet its long-term 2050 greenhouse gas reductions target. These 2030 targets include

- a 40% cut in greenhouse gas emissions compared to 1990 levels;
- at least a 27% share of renewable energy consumption;
- a 30% improvement in energy efficiency (compared to projections) (EC, 2013b).

To meet the targets, the European Commission has proposed the following. Firstly, a reformed EU emissions trading scheme (ETS) is needed. Secondly, new indicators for the competitiveness and security of the energy system, such as price differences with major trading partners, diversification of supply, and interconnection capacity between EU countries are to be developed. Moreover, it provided first ideas on a new governance system based on national plans for competitive, secure, and sustainable energy. These plans will follow a common EU approach and ensure stronger investor certainty, greater transparency, enhanced policy coherence and improved coordination across the EU (EC, 2013b).

According to this document, in the future, the benefits of renewable energy must be exploited in a way which is to the greatest extent possible market driven. The functioning of the ETS and the contribution to GHG reductions from renewables are closely interlinked and complementary. A greenhouse gas reduction target of 40% should by itself encourage a greater share of renewable energy in the EU of at least 27%. The Commission proposes, therefore, that this should be the EU's target for the share of renewable energy consumed in the EU (EC, 2014f).

This EU level target will drive continued investment in renewable energy meaning, for example, that the share of renewable energy in the electricity sector would increase from 21% today to at least 45% in 2030. Unlike in the current framework, the EU target would not be translated into national targets via EU legislation, thus leaving greater flexibility for Member States to meet their greenhouse gas reduction targets in the most cost-effective manner in accordance with their specific circumstances, energy mixes and capacities to produce renewable energy.

The Transport White Paper established a goal to reduce the greenhouse gas emissions from the transport sector by 60% by 2050 compared to 1990 and by around 20% by 2030 compared to emissions in 2008. Greenhouse gas emissions increased by 33% during the period 1990 to 2007 but have since fallen on the back of high oil prices, increased efficiency of passenger cars and slower growth in mobility. This trend is expected to continue up until 2020 but greater efforts will be needed after 2020 to reach the White Paper's targets. Further reduction of emissions from transport will require a gradual transformation of the entire transport system towards a better integration between modes, greater exploitation of the non-road alternatives, improved management of traffic flows through intelligent transport systems, and extensive innovation in and deployment of new propulsion and navigation technologies and alternative fuels (EC, 2014f).

In order to provide a long term perspective on climate, energy and transport (a sector which accounts for a significant share of both GHG emissions and energy consumption), the European Commission came forward with three initiatives in 2011 based on a consistent analytical framework: the Roadmap for moving to a competitive low carbon economy in 2050, the Energy Roadmap 2050, and the Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system (commonly referred to as the Transport White Paper) (EC, 2014f).

The Roadmap for moving to a competitive low carbon economy in 2050 is one of the long-term policy plans put forward under the Resource Efficient Europe flagship initiative intended to put the EU on course to using resources in a sustainable way. The Roadmap suggests that, by 2050, the EU should cut its emissions to 80% below 1990 levels through domestic reductions alone. It sets out milestones which form a cost-effective pathway to this goal - reductions of the order of 40% by 2030 and 60% by 2040. It also shows how the main sectors responsible for Europe's emissions - power generation, industry, transport, buildings and construction, as well as agriculture - can make the transition to a low-carbon economy most cost-effectively (EC, 2011c).

Moreover, energy efficiency will be a key driver of the transition. By moving to a low-carbon society, the EU could be using around 30% less energy in 2050 than in 2005. Households and businesses would enjoy more secure and efficient energy services. More locally produced energy would be used, mostly from renewable sources. As a result, the EU would be less dependent on expensive imports of oil and gas and less vulnerable to increases in oil prices. On average, the EU could save € 175-320 billion annually in fuel costs over the next 40 years (EC, 2011c).

The EU has set itself a long-term goal of reducing greenhouse gas emissions by 80-95% when compared to 1990 levels by 2050. The Energy Roadmap 2050 explores the transition of the energy system in ways that would be compatible with this greenhouse gas reductions target while also increasing competitiveness and security of supply. The Energy Roadmap set out four main routes to a more sustainable, competitive and secure energy system in 2050: energy efficiency, renewable energy, nuclear energy and carbon capture and storage. It combined these routes in different ways to create and analyze seven possible scenarios for 2050 (EC, 2011d).

The Energy Roadmap 2050 involves the following objectives. First, decarbonising the energy system is technically and economically feasible. In the long-run, all scenarios that achieve the emissions reduction target are cheaper than the continuation of current policies. Second, increasing the share of renewable energy and using energy more efficiently are crucial irrespective of the particular energy mix chosen. Third, early infrastructure investments cost less and much of the infrastructure in the EU built 30 to 40 years ago needs to be replaced anyway. Immediately replacing it with low-carbon alternatives can avoid more costly changes in the future. Fourth, a European approach is expected to result in lower costs and more secure energy supplies when compared to individual national schemes. With a common energy market, energy can be produced where it is cheapest and delivered to where it is needed (EC, 2011d).

Having overviewed the targets and objectives, it is now relevant to consider the issue of state policies that support renewables and alternative energy and the outlook for the development of such policies. One of the interesting features of the renewables is that the decoupling of day-ahead market prices and RES feed-in due to FIT regulations, may result in lower average day-ahead price levels and even in negative day-ahead prices for several hours each month. This is called a merit-order effect and it is important to be considered when analyzing future policies towards renewables.

While in the long run support schemes for RES units are likely to be phased-out, and they will thus have to compete in a normal market setup, in the mid-term the power market structure may have to be adapted to the increasing effects of RES deployment. For the subsequent investigation the two relevant perspectives have to be taken into account (Hildmann, Ulbig and Andersson, 2013).

The first is the producer perspective: how to keep the profitability of necessary dispatchable base and peak load power plants in a power market with high shares of RES. This problem arises, since in short- and mid-term, a completely RES based electricity production on its own is not able to provide the necessary production volume or the necessary reliability for fulfilling the load demand at all times throughout the year. Conventional power plants, whose generation output can be controlled, are still necessary for providing base and peak load demand, buffer the lack of wind and PV power feed-in during absences of wind & sunshine and, generally, cover the prediction error of variable RES power feed-in (Hildmann, Ulbig and Andersson, 2013).

According to German Energy Agency, one proposed solution for this problem was the implementation of capacity markets, where (conventional) power plants are rewarded not only for energy delivery but also for providing a firm power capacity. Capacity markets would help to reduce power plant investment risk as they provide an additional revenue stream for power plant owners (dena, 2012).

However, it should be taken into consideration that the introduction of such capacity markets would most likely add some new subsidy mechanism, preventing both an efficient functioning of the energy-only power market and, in the long run, an affordable energy transition to significant RES shares in the electricity sector. Therefore, this idea has to be thoroughly analyzed before possible implementation in order to avoid substituting one subsidizing scheme for another.

The second perspective is the consumer perspective, namely how to lower the cost of FIT schemes and enable the transition to a less subsidized (and eventually true) power market. Out of the many possible support schemes for RES, FIT-based schemes turned out to be highly effective energy policy instruments. As a result, large-scale deployment of RES, especially wind and PV has been remarkably successful. The actual FIT payments, meaning the difference between FIT tariffs and hourly day-ahead market prices, is financed, for example, in Germany through an additional levy on electricity consumption. So, such situation occurs that the average German retail consumer electricity price is nowadays a midst the highest in Europe whereas the average day-ahead whole-sale electricity price is one of the lowest (Hildmann, Ulbig and Andersson, 2013).

Therefore, in order to prevent additional long term price increases, the consumer has the interest in lowering costs for FIT schemes and achieving the integration of RES power feed-in into competitive power market frameworks.

To sum up, this section made an overview of the current trends in the EU energy policy and highlighted the current legislation in the area of energy security, the necessity for which appeared as import-dependence from Russia increased, and the way of renewables development analysis was conducted with respect to objectives and obstacles for future EU energy market development. Experience with the current 2020 framework indicates that while European and national targets can drive strong action by the Member States and growth in emerging industries they have not always ensured market integration, cost-efficiency and undistorted competition. The impact assessment indicates that a main target for greenhouse gas emissions reduction represents the least cost pathway to a low carbon economy which of itself should drive an increased share of renewable energy and energy savings in the Union.

3.3 THE ROLE OF RENEWABLE ENERGY SOURCES IN THE ENERGY STRATEGY OF EU MEMBER STATES

The question of how to secure energy supply is nowadays extremely relevant on the political agenda. However, the energy policy of the EU suffers not only from a shortage of domestic energy resources, but also from a lack of policy coordination at the EU level. This has probably much to do with the particular energy interests of the Member States.

According to article 194 of the Lisbon Treaty, member states have the overall responsibility for securing their energy needs and shaping their energy mixes, thus making them adopt national energy policies that are not always synchronized with the overall EU energy goals or with other EU member states. Therefore, the goal of this section is to reflect on how the separate Member States support renewable sources policies and what role do they outline to the renewables in their energy strategies for the distant future. Moreover, the issue of how the national energy particularities may support or undermine the coherence of the EU's efforts aimed at designing and implementing common energy policy will be briefly considered within the framework of this section.

Last but not least crucial factor is that the EU countries' strategies differ when it comes to supporting fossil fuels, so the renewable sector must compete with a unique price structure for these fuels in each country, therefore energy strategies of France, Germany and Spain will be analyzed separately in order to distinguish the differences in state support policies and features of energy sector developments.

It is also worth mentioning why particularly three Member States were chosen for the analysis, namely Germany, France and Spain. Germany has been the most successful in implementing the renewable energy sources in the EU so far. It showed remarkable results in the usage of PVs as well as developed and among first successfully implemented various renewable and alternative support schemes, which served as an example for other EU members. Moreover, Germany has embarked on an ambitious project to transform its energy system by 2050 (so-called Energiewende), which is worth analyzing.

As for France, for a long time, the general French position has been to maintain the current status quo while observing others in a wait-and-see approach. According to the World Nuclear Association, half of the EU's nuclear electricity is produced in only one country – France (World Nuclear Association, 2015), which provides interest in a more deep investigation, since the issue whether such country would be willing to switch from mainly nuclear to renewable energy production. The political will to reduce the share of nuclear power to 50% from current 75% by 2025 clearly opens a new chapter for French energy policy in the electricity sector, which is worth to be analyzed. French energy transition plan is highly ambitious, at least on paper, and makes it interesting for investigation.

Renewable Energy deployment in Spain is interesting since it has progressed rapidly in the past decade due to a convergence of several factors: a political will to meet the 2020 renewable energy and climate change objectives defined by the European Union, the existence of Research Centers that have spearheaded innovation and commercialization of renewable energy technologies as well as large amount of private sector investment. This country has enormous potential for the development of renewable energy sources such as solar, wind and geothermal in particular, and it is still at the stage of developing its potential, which makes it noteworthy to study.

3.3.1. GERMANY

German policy makers have taken a fundamental policy decision to move towards a sustainable energy supply over the long term. In September 2010, the federal government adopted a comprehensive new strategy, the Energy Concept, which established the principles of a long-term, integrated energy pathway to take the country to 2050 and which determined renewable energy as the cornerstone of future supply. The Energy Concept built on the success of previous policies, notably the Integrated Energy and Climate Programme of 2007, but adopted more ambitious goals (IEA, 2013).

Therefore, Germany stepped onto the path towards becoming one of the world’s most energy efficient and environment friendly economies, while at the same time seeking to maintain affordable energy prices and a high level of economic prosperity. A key feature of the Energy Concept was a proposal to extend the operating lifetime of the German nuclear power fleet by an average of 12 years, therefore postponing the nuclear power phase-out agreed by the former government.

Following the Fukushima Daiichi nuclear accident in March 2011, a political decision which enjoyed extensive public support was taken to accelerate the phase-out of Germany’s nuclear fleet by 2022 starting with the immediate closure of the eight oldest plants. This decision, combined with the political target to further progress towards a low-carbon energy sector, had a major impact on the German energy policy outlook, which resulted in the adoption of a second package of measures, needed to accelerate the energy transition. This second Energy Package, which completed what is commonly known as the Energiewende, contained seven legislative measures to support renewable energy and grid expansion, promote energy efficiency, fund the reforms and reverse the previous decisions to extend the lifetime of the nuclear plants (IEA, 2013).

Next a brief description of the place of renewables in a current German energy provision is provided with further outlining of the renewables role in the policy applications at the modern stage.

I will start with the photovoltaic energy. So, Europe's strong PV market development until 2012 was the result of a few countries taking the lead year after year, with German policymakers showing a constant commitment to supporting the development of PV. After the Spanish boom in 2008, Germany alone was the leading market in 2009, and consequently European growth as a whole was limited. In retrospect this can be seen as a consequence of the first phase of the financial crisis but also as a year of stabilization after the boom PV experienced in 2008. Major growth returned in 2010, with Germany achieving unprecedented installation numbers (EPIA, 2014).

According to EPIA's 2014 report on photovoltaic energy, after holding the world's top PV market position seven times in the last 14 years, Germany was only fourth in 2013 with 3.3 GW, and yet still by far the largest European market. Moreover, Germany installed between 7.4 GW and 7.6 GW of PV from 2010 to 2012. In 2012, the record year for Germany allowed the European market to maintain a reasonable level of 17.7 GW of installations, with 11.4 GW coming from Germany and Italy alone. In 2013, the decline of Germany and Italy as the main drivers of the European market was confirmed. While the sum of the market in other countries remained around 6 GW, the drop in installations in Germany and Italy decreased the total European market to nearly 11 GW. Germany saw steady growth for nearly a decade and clearly represents the most developed PV market, despite the 2013 market downturn (EPIA, 2014).

In most countries however, PV remains a policy-driven market. The introduction, modification or phasing out of national support schemes, which heavily impact the development of PV markets and industries in these countries, also significantly influence EPIA's forecasts and scenarios. Indeed, declining political support for PV has led to reduced markets in several European countries, including Germany.

Turning now to the wind power, it is important to highlight that in terms of annual wind power capacity installations, Germany was the largest market in 2014, installing 5,279.2 MW of new capacity, 528.9 MW of which (10% of total capacity installed in Germany) offshore (EWEA, 2015).

It is worthwhile to look at a national breakdown of wind power installations to understand how Germany has been driving the whole EU market since the very beginning. In 2000, the annual wind power installations of the three pioneering countries – Denmark, Germany and Spain – represented 85% of all EU wind capacity. By 2013, they represented only 36.2% of total installations. In 2014 installations in the three pioneering countries together represented 45.6% of the EU market and were mainly driven by the 63% German market growth (EWEA, 2015).

The next source is hydropower. Today, Germany has about 7,000 MW of installed pumped storage capacity. By 2020, new pumped storage hydropower plants with a capacity of about 2,500 MW will be added. For example, the project Atdorf in the southern part of the Black Forest is leading the current development of pumped storage schemes in Germany and Europe, in terms of overall electricity output, with an installed output of 1,400 MW, total capacity of 13 GWh and the ability to operate 9.5 hours at full capacity (EURELECTRIC, 2011).

The development of renewable energies and the changes resulting from this development require the energy industry to adjust generation and supply structures. Centralized, large-scale power generation technologies located close to consumption centers will be gradually replaced during the coming years by more volatile power generation technologies, which will be increasingly remote from consumption centers. Today, over 45,000 MW of PV and wind power are installed in Germany. In the National Renewable Energy Action Plan (NREAP), the German government targeted an increase of this capacity to about 98,000 MW by 2020 (EREC, 2011). Table 2 shows capacity projections for renewable energy sources in Germany.

Table 2. Existing and projected capacities for renewable energy sources in Germany

	2010	NREAP 2020
Wind-Onshore	27 GW	36 GW
Wind-Offshore	0.2 GW	10 GW
Photovoltaic	17 GW	52 GW
Biomass	6.3 GW	8.9 GW

Source: EURELECTRIC 2011, based on Power Statistics 2011; NREAPs; German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

The promotion of renewable energy is a declared objective of the Federal Government. As a result of this priority status with guaranteed feed-in tariffs, there has been a strong increase in the share of renewable energy in the energy mix in recent years. While renewables only accounted for 6.7% of electricity production in 2001, their share had grown to roughly 20% in 2011. With the current amendment to the Renewable Energy Sources Act, the Federal Government aims to increase the share of renewables in electricity production to 35% by 2020 and to even 80% by 2050 at the very latest (German Federal Ministry of Economics and Technology, 2012).

However, the swift expansion of renewable energy does have its price. The feed-in tariff is financed by electricity consumers through the system of cost real-location under the Renewable Energy Sources Act (known as the renewables surcharge or EEG surcharge). This surcharge is currently 3.59 cent/kWh and will total roughly €14 billion in 2012. When the Renewable Energy Sources Act was introduced, the surcharge was 0.2 cent/kWh (German Federal Ministry of Economics and Technology, 2012). The graph below displays the dynamics of the surcharge development over the period of 2000-2012 in Germany.

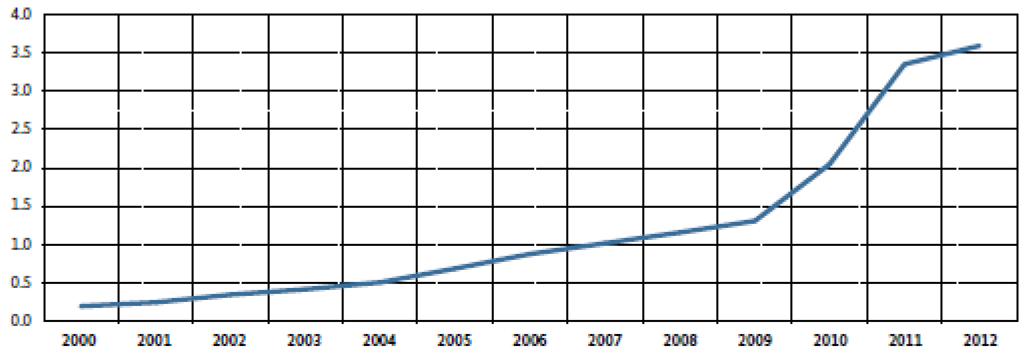

Figure 6. Development of renewables surcharge from 2000-2012 in ct/kWh

Source: Federal Ministry of Economics and Technology

It is worthwhile to investigate how the renewables were incorporated into the German energy strategy and how the government enhanced the development of it. German feed-in tariffs (FITs) for the generation of electricity from renewable sources, under the EEG are entering their third phase of existence (Fulton, Capalino and Auer, 2012).

In Phase One (2000-2009) Germany focused on scaling up domestic renewable electricity generation. With the costs of electricity from technologies such as solar PV far from cost competitiveness, Germany established a FIT policy design that provided transparency, longevity, and certainty (TLC) to investors. During this period, degressions in FIT rates were modest and adjustments to the EEG occurred at regular intervals.

During Phase Two (2009-2011) rapid declines in the cost of solar PV modules prompted Germany to more actively adjust its PV FIT in order to manage the volume of annual PV installations under its FIT programs (by, for example, linking FIT degressions for PV to the volume of PV installations in previous periods and reviewing the PV policy more frequently).

In Phase Three (2012 – present time), continued cost declines are making solar PV, wind, and biomass increasingly competitive with traditional sources of electricity; in response, the key elements of Germany's 2012 EEG – including reduced FIT payments, a market premium option, a 90% cap on FIT-eligible PV electricity, and addition of a 52 GW PV capacity threshold – all mark an evolution of German FITs toward a "grid parity" future where policy is more flexible and may offer less TLC to investors. Indeed, in terms of "gird parity", the cost of electricity from small PV systems in Germany is in some cases already below retail rates (Fulton, Capalino and Auer, 2012).

A central goal of Phase Three is to encourage renewable generators to behave more like conventional generators – chiefly, in considering the wholesale market value of the energy that they produce. Traditional FIT contracts reward the production of renewable electricity irrespective of where and when that electricity is produced.

With respect to this, there is one more issue to be addressed by the German government regarding the development of the renewable and alternative energy, and this issue is the market integration of renewables which is becoming increasingly important. The problem is that due to the guaranteed sales and feed-in tariff under the Renewable Energy Sources Act, renewable electricity is also produced and fed into the grid even if there is no demand for power. This is because the plant operators also qualify to receive the feed-in tariff if their electricity is not needed.

With a combined installed capacity of wind & PV units of around 70 GW by year-end 2013, somewhat higher than the average load demand in Germany (63–68 GW dependent on load demand measure), wind & PV units clearly cannot be treated as exotic, marginal electricity sources anymore. The current RES production has already significant effects on the power market, notably in the form of the so-called merit-order effect. Especially the decoupling of day-ahead market prices and RES feed-in due to FIT regulations, results in lower average day-ahead price levels and also in negative day-ahead prices for several hours each month.

In today's European power market environment in which significant over-capacities exist, yearly average spot market prices as well as base-peak spreads in Europe are at their lowest in years. One effect of this is that flexible power plants such as gas-fired units cannot be operated profitably because peak day-ahead prices are too often below their marginal operation costs. Another effect is that due to the also decreasing spread of peak/base day-ahead prices, the profitability of operating energy storage facilities, i.e., pumped storage hydro plants (PSHP) has been diminishing in recent years (Hildmann, Ulbig and Andersson, 2013).

Therefore, while conventional power stations take their lead from the prices on the power markets and use this as their basis to control power plant operation, renewable energy plants can produce electricity regardless. Renewable energy systems are therefore immune to the pricing signal of the power market. Given the limited possibilities of storing electrical energy, however, this affects the electricity exchange: for example, prices drop when the supply of wind power is high particularly in times when low demand for electricity (e.g. holidays or weekends) coincides with high electricity production from renewable energy installations. The upshot is low or even negative electricity prices on the exchange. Non-demand-responsive production then causes electricity to be sold below value. In the case of negative prices, electricity providers even have to pay buyers to purchase their electricity. This may first sound impossible, but it does happen in reality.

In Germany, rapid addition of wind and solar generation has resulted in the supply of electricity exceeding demand during several periods of the year, which has caused electricity market prices to plummet to zero (and below). While beneficial to some consumers (in the short term, at least), such

The future integration of these variable power quantities requires a swift extension of national and European power storage capacities. The wind does not always blow and the sun does not always shine at the exact moment when consumers' power demands are high. Consequently, in order to make renewable energy available at times of peak demand, a large amount of storage capacity is required. Apart from the development of smart grids and the implementation of flexible generation plants, electricity storage facilities of any technology, such as pumped storage power plants, compressed-air reservoirs, accumulators, etc. will be of critical importance.

3.3.2. FRANCE

France is the European Union's second largest producer and consumer of renewable energy. In 2011, power generation from renewable energy sources represented 13.1% of France's electricity production (Norton Rose Fulbright, 2013).

Rich in diverse renewable energy resources, France has the largest forest area in Western Europe, the second highest wind energy potential (with its 5,500 km of coastline) and extensive hydroelectric resources that make it the second largest market in Europe in terms of electricity capacity. In addition, the country's strong agricultural sector lends itself to the development of bio-energy and French overseas territories offer considerable potential for solar developments.

France's energy policy is focused mainly on nuclear power, which in 2011 accounted for 79 % of France's electricity production. Nevertheless, policy support for renewable energy has increased over the last decade and France moves slowly towards more sustainable resources of renewable electricity which should in time speed up the process of developing renewable energy projects (Norton Rose Fulbright, 2013).

The two main sources of renewable energy in use in France are biomass and hydropower. RES currently being developed include wind energy, solar energy (thermal, photovoltaic and, in French overseas territories, concentration), hydroelectric and marine energy, bio-energy, geothermal energy, thermodynamic heating and hydrogen-based generation.

As of March 2015, France derives about 75% of its electricity from nuclear energy, due to a long-standing policy based on energy security. This share is to be reduced to 50% by 2025. Moreover, France is the world's largest net exporter of electricity due to its very low cost of generation, and gains over €3 billion per year from this. About 17% of France's electricity is from recycled nuclear fuel (World Nuclear Association, 2015).

Total generating capacity (end 2014, RTE data) is 129 GWe, including 25.4 GWe hydro, 24.4 GWe fossil fuel, 9.1 GWe wind and 5.3 GWe solar PV. Peak demand is about 100 GWe. In 2013 gross production was 424 TWh from nuclear, 76 billion kWh from hydro, 24.7 billion kWh from coal, 17.7 billion kWh from natural gas, 20.6 from solar and wind, and 8.0 from biofuels & waste, of total 575 TWh (World Nuclear Association, 2015).

The present situation is due to the French government deciding in 1974, just after the first oil shock, to expand rapidly the country's nuclear power capacity, using Westinghouse technology. This decision was taken in the context of France having substantial heavy engineering expertise but few indigenous energy resources. Nuclear energy, with the fuel cost being a relatively small part of the overall cost, made good sense in minimizing imports and achieving greater energy security.

As a result of the 1974 decision, France now claims a substantial level of energy independence and almost the lowest cost electricity in Europe. It also has an extremely low level of CO_2 emissions per capita from electricity generation, since over 90% of its electricity is nuclear or hydro (World Nuclear Association, 2015).

In 1999 a parliamentary debate reaffirmed three main planks of French energy policy: security of supply (France imports more than half its energy), respect for the environment (especially regarding greenhouse gases) and proper attention to radioactive waste management. It was noted that natural gas had no economic advantage over nuclear for base-load power, and its prices were very volatile. It was accepted that there was no way renewables and energy conservation measures could replace nuclear energy in the foreseeable future.

In 2005 a law established guidelines for energy policy and security. The role of nuclear power is central to this, along with specific decisions concerning the European Pressurized Water Reactor, notably to build an initial unit so as to be able to decide by 2015 on building a series of about 40 of them. It also set out research policy for developing innovative energy technologies consistent with reducing carbon dioxide emissions and it defined the role of renewable energies in the production of electricity, in thermal uses and transport.

In October 2014 an energy transition bill was passed by the National Assembly and so went on to the Senate. Besides other goals, the document aims to reduce fossil fuel consumption by 30% by 2030 relative to 2012; and to increase the share of renewables in final energy consumption to 32% by 2030 (World Nuclear Association, 2015).

So, as of now the structure of the national energy mix has remained relatively stable. According to the European Commission, nuclear energy continues to hold the highest market share (approximately 43%), followed by oil products (32%) and natural gas (14%) (EC, 2014g).

France has an obligation to reach 23% of RES share in gross final energy consumption by 2020. Despite the fact that France has stayed somewhat below its 2011/2012 interim target (12.8%), the share of renewable energy has nevertheless increased from 11.3% (2011) to 13.4% thus showing a positive trend (2012). This positive result is mainly due to contribution from the heating and cooling sector, which increased as a result of improved use of biomass (EC, 2014g).

Latest statistics as of 2014 evidences that renewable energies continued to grow in 2012: +4.6% in the residential sector and +9.3% in the tertiary sector. Consumption of wood, which represents 80% of renewable energies in the residential sector, grew marginally due to the success of new high-performance wood-burning appliances. The development of heat pumps continued: these reached 12% of household consumption of renewable energy. These strong developments of renewable energies are in line with previous years: Since 2007 an annual average rise of +4.5% in the residential sector and + 6.7% in the tertiary sector (Ministry of Ecology, Sustainable Development and Energy, 2014).

According to the National Energy Efficiency Action Plan – 2014, the multiannual scheduling of heat investments (called "heat PPI") expects a significant growth of the number of solar thermal collectors installed between 2006 and 2020. The fixed objective for the production of 817 ktep of renewable heat from individual solar thermal installations in 2020 translates into almost 30% of equipment in individual dwellings multiplying almost by 48, compared to 2005, the solar energy generation in this sector. In the field of collective installations (collective housing, tertiary housing), the expected growth of collective solar energy corresponds to a multiplication factor of 11 of the production in 2005 in order to achieve 110 ktep in 2020. Financial aid for solar energy in the residential sector is integrated by a global policy for the development of renewable energy in the building sector (see Residential-tertiary section). Special emphasis has been placed within the 2012 Thermal Regulations, on encouraging the installation of individual solar water heaters for new private houses built from 2013. In the collective, tertiary, agricultural and industrial sectors, financial support for solar energy is guaranteed by the heat funds and by the CPER. The generation of renewable heat from solar power is growing with 133 ktep in 2012 against 49 ktep in 2005 (Ministry of Ecology, Sustainable Development and Energy, 2014).

As for solar power, a significant growth in renewable energy generated by heat pumps thanks to heat PPI is expected by 2020. The objective of the total generation of renewable energy starting from PAC, in all sectors, was increased to 1 300 ktep in 2012 and to 1850 ktep for 2020 with a production in 2012 estimated at 1 227 ktep. In the residential sector, financial support for the development of heat pumps falls within the global policy of financial support for the development of renewable energy in the building sector. Financial support for geothermal energy saw a sharp rise in 2010 including the expenses fronted to lay underground heat exchangers within the bases of Sustainable Development tax credit in favor of geothermal heat pumps. In the collective, tertiary, agricultural and industrial sectors, financial support to geothermal heat pumps is guaranteed by the heat funds (Ministry of Ecology, Sustainable Development and Energy, 2014).

It should be also mentioned that the development of geothermal energy has been identified by France as one of the priority sectors for green growth and in the fight against climate change and is subject to a ”green sector” approach”.

In France, electricity from renewable sources is promoted through a feed-in tariff and tax benefits. The generation of heat through renewable energy plants is promoted through several systems of energy subsidies, tax regulation mechanisms as well as through a zero percent-interest loan. The main support scheme for renewable energy sources used in transport is a quota system. Furthermore, biofuels are supported through fiscal regulation (RES LEGAL Europe, 2015).

The use of the grid for the transmission of electricity from renewable sources is subject to the general legislation on energy. There are no special provisions for electricity from renewable sources. As far as heating and cooling is concerned, public distribution of heat in France is a competence of the local or regional authorities. The procedure of grid connection is at the same time also the procedure for grid development, since the construction of a plant must occur simultaneously with the construction of the district heating grid.

There are various policies aiming at promoting the development, installation and use of RES installations in France, including training programs, certification schemes or Research, Development and Demonstration (RD&D) programs.

In general there are two types of training programs for installers of RES-systems: the association Qualit´EnR promotes quality installations in the field of solar thermal energy, photovoltaic, biomass as well as heat pumps. The organization Qualibat grants qualifications and certifications to professionals of the building trade, including installers of renewable energy plants (RES LEGAL Europe, 2015).

As far as the exemplary role of public authorities is concerned, there is no program of the French government promoting the development of a specific renewable energy technology in public buildings. However, the Grenelle Building Plan was established in order to reach the targets set by the Grenelle of Environment in all building sectors, including public buildings (RES LEGAL Europe, 2015).

There are two support schemes for RES-H infrastructures. The Heat Fund supports the production of heat through renewable energy plants as well as the use of district heating. Moreover, under certain conditions, the supply of heat through district heating networks can be subject to a reduced VAT of 5,5% (RES LEGAL Europe, 2015).

It is also important to address main opportunities and challenges facing the renewable energy sector of France. Generally speaking, renewables are now the fastest-growing sector of the energy mix and offer great potential to address issues of energy security and sustainability. France will have to support and accelerate the development of renewable energies - and especially wind and solar power - in order to meet its obligations under the Renewable Energy Directive and have 23% of final energy demand from renewable sources by 2020. There are several reasons to suggest that this objective will be difficult to meet.

Regulation of the RES sector supplies challenges as well as support. Frequent recent changes to legislation and regulation and the addition of new authorization requirements continue to hinder the pace of development of renewable energies. Moreover, strict compliance with the French legislation is key to the success of a renewable project. It is essential to build up relationships with contacts in France and patience is necessary as it is not uncommon to take up to four years to achieve results. Finally, French-speaking African countries show a growing interest in the development of renewable energies (such as in the Tarfaya site or the Ouarzazate site in Morocco) (Norton Rose Fulbright, 2013). Opportunities for renewable energy investments in Africa should diversify in the near future.

The last issue to be addressed within this section is renewable energy industry policy recommendations as provided in European Renewable Energy Council report "Mapping Renewable Energy Pathways towards 2020" (EREC, 2011).

In electricity sector, there have been frequent changes in regulations on authorization for renewable energy over the past years. It appears necessary to stabilize regulations so that operators can work in better conditions. There is no one-stop-shop for obtaining authorizations for RES-E projects, and this is a weak point in the existing system. The distribution grid needs urgent modernization and RES need to be favored on the grid. Furthermore, it is also essential to develop and strengthen grid infrastructure and grid lines in certain zones, especially where problems arise at the present time and in areas where RES projects are likely to be developed in the future.

Turning now to heating and cooling sector, it would seem crucial to introduce a minimum level of RES in the overall consumption of buildings (e.g. by introducing a minimum consumption threshold of 5 kWh/m2 .year). For public buildings to fulfill an exemplary role by 2012, all constructions or major renovations of public buildings should incorporate a minimum level of RES. The budget of the "Fonds Chaleur" may be reviewed yearly and is therefore unstable. Another system of financing should be preferred. Finally, administrative procedures to install RES-H&C systems must be simplified (EREC, 2011).

Now, last to consider is the transport sector. Due to the current absence of a national scheme on the compliance of biofuels and other bioliquids to sustainability criteria, economic operators could favor the voluntary scheme in France. Indeed, economic operators are entitled to use the voluntary scheme that they have elaborated, provided this voluntary scheme has first been recognized by the European Commission and been through the comitology process. In terms of measures to ensure that economic operators submit reliable information and show that the sustainability criteria has been fulfilled, it would seem advisable for the main checking point to be at the custom level when fuels are put on the market, as there are already various control systems at this level. As far as voluntary certification schemes for the sustainability of biofuel and bioliquids are concerned, all options should be authorized, a national system or a voluntary scheme. However, in the latter, the economic operator may have more flexibility to design a system that is adapted to its economic constraints. SER estimates that public authorities could, via a FiT system or via subsidies, give premiums for installations using biomass coming from arable land, degraded land, etc., which would encourage their use for energy purposes (EREC, 2011).

3.3.3. SPAIN

Spain is the fifth largest energy consumer in Europe and has virtually no domestic production of liquid fuels or natural gas. Government regulation limits the percent of total oil and gas imports any single country may sell to Spain to ensure diversity of supply.

Liquid fuels are still the largest source of Spain's total energy consumption, mostly in the transportation sector. The country had nine refineries with a total crude oil refining capacity of almost 1.3 million barrels per day as of January 2014, according to Oil & Gas Journal. However, Spain is still a net importer of petroleum products (EIA, 2015).

Up until the 2008 financial crisis, Spain was one of the fastest-growing natural gas markets in Europe. Although growth has slowed since then, Spain still accounted for nearly two-thirds of LNG imports to OECD Europe in 2013. Spain fell to 6th largest global importer of LNG in 2013, as India, China, and Taiwan surpassed it, and Spanish imports have declined, according to IHS Energy (EIA, 2015).

Spain also receives significant natural gas supplies from Algeria through the undersea Maghreb-Europe Gas Pipeline, which came on line in 2011 after a number of delays. In 2013, Algeria supplied 39% of Spain's natural gas (BP Statistical Review of World Energy, 2014).

Spain generates a significant amount of power from wind energy, the most of any country in Europe as of 2012. The Spanish government authorized offshore electricity generating facilities in 2007 to promote the development of offshore wind energy. Renewable energy, including hydroelectric generation, accounted for 30% of Spain’s power generation in 2012 Energy (EIA, 2015).

Up until the 2008 recession, Spain was slowly phasing out its coal production subsidies. However, coal production and consumption increased in 2011 after the Spanish government introduced domestic coal production subsidies and gave preferential access to the wholesale power market to coal-powered generators in an attempt to reduce the country's dependence on imported coal. This has caused electricity producers to substitute away from renewables to coal. In 2012, fossil fuels accounted for 49% of Spain’s electricity generation. According to the Framework Plan for Coal Mines and Mining Communities 2013-2018, production subsidies will end after 2018.

There are eight operating nuclear reactors in Spain, which supplied about 21% of the country's electricity generation in 2012 (EIA, 2015).

Spain consumed 14.9 Mtoe of renewable energy in 2011, which represented 11.6% of the country's primary energy consumption. Biomass, wind and hydropower are the main sources of renewable energy. In terms of power generation, the gross renewable energy production amounted to 86,600 GW h, or 29.7% of the country's total. This distribution implies that renewables are the main source of electrical energy for the country, surpassing natural gas (28.9%) and nuclear power (19.7%). The distribution within the renewable energy sector by type has indicated an 84% contribution by wind and hydropower (49% and 35%, respectively), which is an 11% decrease from 2010 due to a year of reduced hydraulic and wind resource availability (Montoya, Aguilera and Manzano-Agugliaro, 2014).

The importance of the renewable energy sector to the Spanish economy has been growing, and its contribution will increase in the next few years. In constant terms based on 2010 values, the direct contribution of the renewable energy sector to Spain's gross domestic product (GDP) has shown positive development, accumulating a growth of approximately 56.7% over the period 2005–2009. Considering the published International Monetary Fund forecasts for the Spain's growth in GDP until 2015, and assuming an annual growth of 2.5% between 2016 and 2020, the direct contribution of the country's renewable energy sector will represent 0.88% of its GDP in 2015 and 1.03% in 2020. The potential for Spanish renewable energy is broad, and far superior to its domestic energy demand and existing fossil-based energy resources (Montoya, Aguilera and Manzano-Agugliaro, 2014).

Among these energies, the potential for solar energy is the highest. Expressed in terms of installable electrical power, Spain has the potential for several terawatts (TW) of solar energy. Wind power takes second place, with a potential estimated at approximately 340W. The country's hydroelectric potential, estimated at approximately 33 GW, is also very high, but the greater part of this potential has already been developed. The remaining technologies have a potential near 50 GW, the potential for wave and geothermal energy approximately 20 GW each.

Spain has hours of sunshine than almost any other country in Europe, along with the countries in the Mediterranean arc, and therefore offers optimal conditions for solar energy. Meanwhile, wind energy, the fastest-growing form of sustainable energy, has surmounted many of the issues associated with more conventional fuels, making it not simply an alternative but a viable, mainstream form of power generation. Spain has been a leader in the deployment of wind energy. Spanish wind turbine manufacturers are international leaders, being among the world's 10 largest manufacturers and commanding a joint market share of 16.4% in 2002.

Of the renewable energy sources, wind energy has experienced the greatest growth in Spain during the last decade. The diffusion of on-shore wind power over the period 1995–2004 has been described as impressive and made Spain the second in wind energy installed capacity, behind only Germany and on par with the US (Graber, 2005). In just 12 years, the contribution of wind energy has gone from being considered insignificant to playing a substantial role in the country's electrical balance. At the end of 2012, wind had generated approximately 22,622 MW of power in Spain, with an electrical output above 48,212 GW h and met approximately 18% of the total national electricity demands, having occasionally surpassed 21% of monthly demands and even 60% coverage in terms of hourly delivery (Montoya, Aguilera and Manzano-Agugliaro, 2014).

Hydropower is dependent on a country's geography. Spain has a significant, consolidated hydroelectric generation system resulting from a long historical tradition of hydropower development due to the country's terrain and a large number of dams. The total capacity of the country's reservoirs is 55,000 H m^3, and 40% of that capacity corresponds to hydroelectric dams, of which Spain has one of the highest proportions in Europe and the world. Spain ranks fifth in hydroelectric power at the European level, after Sweden, France, Austria, and Italy.

It is interesting to note how the production of energy rises and falls depending on annual rainfall. For example, 2010 was a very rainy year in Spain, resulting in a peak production of 6748 GW h, in contrast to 2011 and 2012, when rainfall was lower and production dropped to 5280 GW h and 4620 GW h, respectively. On the other hand, the country's installed capacity has been essentially stable in the last few years. Only 19 MW have been put into operation in the past three years (although 2 MW were uninstalled), which brought the total installed power in Spain to 2035 MW by the end of 2012 (Montoya, Aguilera and Manzano-Agugliaro, 2014).

Therefore, the Renewable Energies Plan 2005–2010 objective of 2199 MW has not been fulfilled. The causes of this low capacity have included the risk arising from this type of project, the increasing complexity of the business, and administrative obstacles that make obtaining permits and licenses for power installation a difficult and costly process in terms of time and resources.

The installed forecasts for 2015 and 2020 included in the plan for renewable energies have been updated in the 2011–2020 plan, with more reasonable objectives, to be 2017 MW and 2185 MW, respectively (EREC, 2011).

Aside from the solar, wind, biomass, and hydraulic sectors, the development of other renewable energy sources has still been very limited in Spain, and production has focused on demonstration projects with the objective of establishing more efficient prototypes. The two most advanced technologies in this sector have been marine and geothermal energy.

Spain has a long coastline and good wave energy resource that could significantly contribute to its renewable energy mix. While the development of marine technology is still in its infancy, the industry has been primarily focused on wave and current technology. There are nearly 30 active projects (technological and normative-methodological) in development on the Spanish coast, with an estimated investment of more than 230 million Euros. These investments are located mainly in the northern coastal regions of Spain and the Basque Country, Cantabria, Asturias, and Galicia, as well as in the Canary Islands. The Renewable Energies Plan for 2011–2020 has estimated a marine energy production potential of 220 GW h and established a series of measures to promote the deployment of 100 MW of marine energy by 2020 (Montoya, Aguilera and Manzano-Agugliaro, 2014)..

Despite the large estimated geothermal energy resources in Spain (approximately 19,000 MW, of which 1000 MW could be exploited), their exploitation would be expensive and require further technological development. The Renewable Energies Plan of 2011–2020 has set a goal of 50 MW by 2020 and estimated that the first plants will be operational by 2017. There are boreholes and small facilities located at several places across the country, mostly on the Mediterranean coast and near Madrid. Spain installed 22.3 MW by 2007, using 347.2 TJ/yr with a capacity factor of 0.49 (Spain's National Renewable Energy Action Plan 2011-2020, 2010).

In Spain, the generation of electricity from renewable sources is mainly promoted through a price regulation system. Plant operators may choose between two options: a guaranteed feed-in tariff and a guaranteed bonus (premium) paid on top of the electricity price achieved on the wholesale market.

In Spain, renewable energy plants are statutorily entitled to priority access to, connection to and use of the grid. Renewable electricity is granted priority dispatch in the electricity markets at no cost, provided the stability and security of the grid infrastructure can be maintained. Renewable energy plants operate under the so-called “Special Regime” (RES LEGAL Europe, 2015).

Plant operators may be contractually entitled to the expansion of the grid. If the expansion is required for a plant to be connected to the grid, the operator of the plant has to bear the costs of the expansion works (“deep” connection charges). Apart from that, the grid operator is obligated to expand his grid in compliance with the general legislation on energy (RES LEGAL Europe, 2015).

Spain has a national training system for installers and an obligatory certification for solar thermal panels. In addition, there are two wider frameworks, the R&D plan and the building code, that include RES as an area of interest.

As of February 2015, according to Forbes, the renewable energy industry in Spain is “coming back from the dead”. The Spanish Ministry of Industry said it would support installation of roughly 8.5 gigawatts (GW) of renewable energy capacity between 2015 and 2020. The new capacity will increase Spain’s total installed renewable energy capacity from 48 GW in 2015 to about 57 GW in 2020. More specifically, the initiative will support installation of nearly 6.5 GW of wind power capacity, 1.5 GW of solar photovoltaic facilities and about 211 megawatts (MW) of solar thermal power plants. However, projects supported by the new programs will require financial guarantees from renewable energy developers. The reports indicated that renewables developers will be required to put forward financial guarantees for projects in order to access government subsidies - a move designed to guard against a rush of new projects that could exceed the subsidy budget (Forbes, 2015).

The new target comes after the Spanish government controversially imposed retroactive changes to the country's renewable energy subsidy regime, responding to concerns about the scheme's cost by imposing a cap on the returns renewable energy project owners could realize.

The policy u-turn had a dramatic impact on a renewables sector that had been one of the most vibrant in Europe, with official figures showing that new solar installations crashed from 105MW in 2013 to just 7MW last year. New figures this week from the European Wind Energy Association similarly confirmed that Spain lagged well behind the leading European markets for new wind energy installations last year (BusinessGreen, 2015).

Renewable Energy deployment in Spain has progressed rapidly in the past decade due to a convergence of several factors: a political will to meet the 2020 renewable energy and climate change objectives defined by the European Union, the existence of Research Centres that have spearheaded innovation and commercialization of renewable energy technologies as well as large amount of private sector investment.

As a result, one third of Spain's electricity is generated from renewable sources. Spanish companies have also emerged as world leaders in a number of renewable energy technologies, notably wind power and concentrated solar. All this have been brought about by generous public funding schemes in R&D and early stage commercialization as well as fiscal and regulatory policies supportive of a rapid expansion of the renewable energy market. The European crisis has prompted significant policy changes that could jeopardize the continuity of existing support schemes and negatively affect the state of renewable energy in Spain (Australian National University, 2013).

Summarizing, the growth in the use of Renewable Energies in Spain has been remarkable. Among these energies is solar thermal energy. Over recent years, various measures have been adopted to enhance and promote the use of solar thermal energy. These measures have been developed at all administrative levels: central, regional and local. One of the most used measures has been the adoption of legislative regulations that force the use of this type of energy in construction. Another alternative route is promotion by means of incentives, in three aspects: tax incentives, non-refundable grants and favorable lines of finance. However, the measures applied have been found to be insufficient, and alternative stimuli are needed.

CONCLUSION

Europe's demand for energy is increasing in an environment of high and unstable energy prices. Greenhouse gas emissions are rising. Natural reserves of fossil fuels such as oil and gas are concentrated in just a few supplier countries around the world. The global oil market has become extremely volatile and particularly the EU dependence on oil continues to grow. The unreliability of the fossil fuels suppliers first of all regarding Russia creates threats to the European countries' energy security. Therefore, with more emphasis on renewable energy and using domestic renewable energy sources instead of importing foreign oil the EU would drastically improve its energy security and energy independence.

Moreover, climate change along with an increasing dependency on energy imports are only a few of the risks the European economy is facing today. As energy is the fuel of the EU economic engine, by switching from fossil fuel, greenhouse gas intensive sources of energy to renewable sources of energy, the EU is able to fully grasp its sustainable potential - in economic, ecologic and social terms.

Based on the abovementioned current energy security problems and benefits that could be obtained by using the renewable and alternative energy sources, this study investigated the EU past and present energy supply and consumption patterns with an emphasis on renewable and alternative energy supporting policies. Moreover, the role of renewable and alternative energy sources in the energy strategy of three EU Member States was analyzed in order to identify how wise government policies and encouraging incentives can have a real impact on the fortunes of attaining high energy security and efficiency.

In addition to this, the paper aimed at verifying two hypotheses. First hypothesis as to whether the share of alternative and renewable energy will be sufficiently large to contribute to solving a problem of the EU energy security and independency has been confirmed. The dynamic and structural analysis of the renewable and alternative energy sources usage nowadays in the EU in general and its Member Countries considered separately demonstrated that the EU strives to ensure its energy security by setting ambitious long term horizon goals regarding the use of the renewables. Thus, under the European Union's 20/20/20 policy renewable electricity capacity has increased significantly in the past 10 years. This growth, fuelled by political, economic and environmental imperatives, will see renewables continue to play an increasing role in the European energy mix over the next decade. Moreover, the analysis of targets set for 2030 and 2050 by the EU demonstrated the intention to dramatically increase the share of alternative sources in transport sector particularly, as well as share of renewables in electricity and heating sectors of the EU. However, the analysis of the contractual obligations of the EU countries with Russia demonstrated that the process of replacement imported energy sources with alternative and renewable will take quite a long time, however the EU Member states work actively on that issue. Apart from implementing its environmental policies, the EU ensures the security and reliability of the energy sources supply of its Member States.

The second hypothesis as to whether renewable energy sources will reduce dependency of the EU and its Member States on Russia and other fossil fuel exporters has also been partly validated. The analysis of the main EU import partners (with respect to fossil fuels) showed that many EU member countries are also heavily reliant on a single supplier, including some that rely entirely on Russia for their natural gas. This dependence leaves them vulnerable to supply disruptions, whether caused by political or commercial disputes, or infrastructure failure. Based on this evidence together with the analysis of alternative and renewable energy sources possibilities in the EU, the conclusion was drawn that the EU will highly benefit in terms of energy efficiency and, what is most important, energy security from its active supporting policies regarding the renewables. However, among the main finding of this paper was that there is limited scope for significantly reducing overall European dependence on Russian gas before the 2020s even though the targets set by the EU have chances to be met.

Thus, in this study a comprehensive analysis of past and current trends of the EU energy market has been conducted. The role of renewable and alternative energy sources has been identified and explained in the context of current global and regional political and economic situation as well as environmental and social issues taken into account. Furthermore, a more thorough analysis of separate sectors of renewable energy sources, their supply and consumption as well as three EU Member Countries national energy markets and strategies was carried out. The objective of that was to evaluate how governmental policies support the renewables and what effects are obtained. As a result of this investigation, the following conclusion was reached: despite growing interest in promoting renewable energy, many support measures in Europe targeting fossil fuels and nuclear sectors are still in place, and continue to affect public budgets.

Last but not least the EU long term goals with respect to the renewable energy sources were studied as well as some forecasts regarding the renewable sector future development. Based on the data from recent reports by various organizations related to energy sector, the conclusion was obtained that the EU is capable of reaching its goals set for 2020, 2030 and 2050, and its member countries work intensively towards reaching their targets.

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LIST OF APPENDICES

Appendix A: Wind Power in the EU 88
Appendix B: Renewables in gross final energy consumption in the EU, 2020 targets 89

APPENDICES

Appendix A

Wind Power in the EU

Table A1. Wind power penetration in the EU

Total EU electricity consumption (TWh)	2,798
Onshore wind energy production (TWh)	254.43
Offshore wind energy production (TWh)	29.59
Share of EU consumption met by onshore wind (TWh)	9.1%
Share of EU consumption met by offshore wind	1.1%
Share of EU consumption met by wind	10.2%

This table represents wind power penetration levels, calculated using average capacity factors onshore and offshore and Eurostat electricity consumption figures as of 2012.

Appendix B

Renewables in gross final energy consumption of the EU, 2020 targets

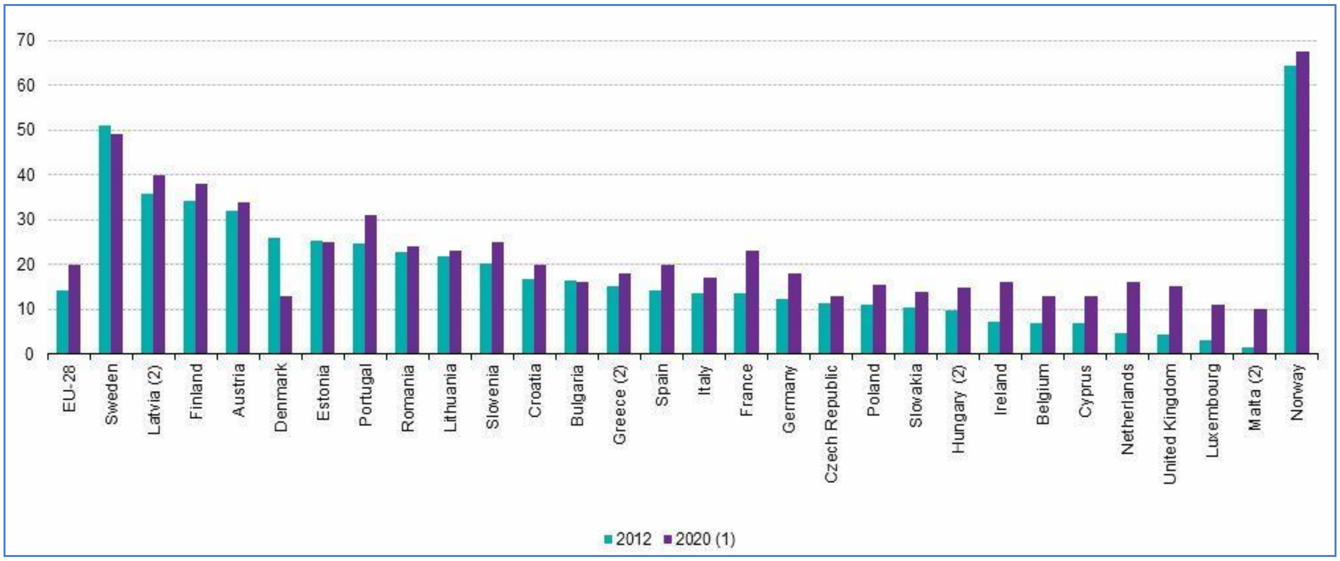

Fig.B1. Share of renewables in gross final energy consumption, 2012 and 2020

Source: Eurostat